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Abstract

Own Group Recognition Bias (OGRB) is a robust phenomenon defined by being better able to recognize individuals from one's own ethnic group compared to other groups. A number of researchers agree that this bias is a function of perceptual and social contact. The aim of this thesis was to investigate the role of contact in the OGRB, particularly in its social dimension, and to understand more broadly how a set of social and cognitive components can act on face recognition. This work was based on two main approaches. The first was to assess the effects of social and cognitive components on the ability of European observers to recognize European and North-African faces. Specifically, I investigated contact patterns, prejudice, interaction anxiety and visual strategies in the context of the OGRB. To this end, I first created and tested scales to measure aspects of social contact, and prejudice towards North-African individuals. The social contact investigation was of three major sub-components of contact, including contact avoidance. The prejudice scale contained two attitudinal components, with items assessing ethnic prejudice and affective states. Then, I set up an experimental protocol using an eye-tracker and physiological measures to assess the impact of different components such as contact, intergroup anxiety, visual strategies and prejudice on face recognition. The main objective of this first part of the thesis was to determine the multiple interdependent effects between cognitive and social elements on intergroup face recognition abilities. The results of the experimental protocol confirmed the existence of an OGRB in European participants towards North-African individuals; however the impact of social variables on face recognition was not conclusive. The study of visual strategies, however, showed clearer results.

In a second part of my thesis, I addressed the notion of within-group variability and how this component can be integrated with the different elements mentioned above. First, I conducted a systematic review of the notion of 'phenotypicality bias', which is defined as the activation of prejudice based on perceived typicality of an ethnicity. This review highlighted an under-developed body of work that challenges the conception of the ethnic group as a homogeneous entity. In a second phase, I tested a set of protocols on the representation and perception of within-group variability for stimuli from African, European and North-African groups. This work allowed me to highlight elements perceived as typical of a given group and to create and validate standardised photographic material with different levels of percieved ethnic typicality. Finally, I manipulated this ethnic typicality in a final experimental face recognition protocol in order to assess its impact on the OGRB. The results of this last study also confirm an OGRB for African and North-African stimuli in a European population. The

impact of within-group variability on recognition was relatively clear, especially for ethnic other-group faces.

Résumé

Le biais de reconnaissance endogroupe (BRE) est un phénomène robuste qui se définit par une meilleure capacité de reconnaissance des individus de son propre groupe ethnique par rapport aux autres groupes. Un certain nombre de chercheurs s'accordent à considérer que ce biais est fonction du contact perceptif et social. L'objectif de cette thèse était d'investiguer cette fonction du contact, notamment dans sa dimension sociale, et de comprendre plus largement comment un ensemble de composantes sociales et cognitives peuvent agir sur la reconnaissance des visages. Ce travail s'est appuyé sur deux approches principales. La première consistait à évaluer les effets des composantes sociales et cognitives sur la capacité des observateurs européens à reconnaître les visages des Européens et des Nord-Africains. Plus précisément, j'ai étudié les modes de contact, les préjugés, l'anxiété d'interaction et les stratégies visuelles dans le contexte du BRE. À cette fin, j'ai d'abord créé et testé des échelles pour mesurer les aspects du contact social et les préjugés envers les individus nord-africains. L'échelle de contact social portait sur trois sous-composantes majeures du contact, dont l'évitement du contact. L'échelle de préjugés contenait deux composantes attitudinales, avec des items évaluant les préjugés ethniques et les états affectifs. Ensuite, j'ai mis en place un protocole expérimental utilisant un eye-tracker et des mesures physiologiques pour évaluer l'impact de différentes composantes telles que le contact, l'anxiété intergroupe, les stratégies visuelles et les préjugés sur la reconnaissance des visages. L'objectif principal de cette première partie de la thèse était de déterminer les multiples effets interdépendants entre les éléments cognitifs et sociaux sur les capacités de reconnaissance des visages intergroupes. Les résultats du protocole expérimental ont confirmé l'existence d'un BRE chez les participants européens envers les individus nord-africains ; cependant l'impact des variables sociales sur la reconnaissance des visages n'a pas été concluant. En revanche, l'étude des stratégies visuelles a montré des résultats plus clairs.

Dans une deuxième partie de ma thèse, j'ai abordé la notion de variabilité intra-groupe et la manière dont cette composante peut être intégrée aux différents éléments mentionnés ci-dessus. Tout d'abord, j'ai effectué une revue systématique de la notion de "biais de phénotypicalité", qui est définie comme l'activation de préjugés basée sur la perception de la typicité d'une ethnie. Cette revue a mis en évidence un ensemble de travaux sous-développés qui remettent en cause la conception du groupe ethnique comme une entité homogène. Dans un second temps, j'ai testé un ensemble de protocoles sur la représentation et la perception de la variabilité intra-groupe pour des stimuli issus de groupes africains, européens et nord-africains. Ce travail m'a permis de mettre en évidence des éléments perçus comme typiques d'un groupe donné et de créer et valider un matériel photographique standardisé avec différents niveaux de

variabilité phénotypique. Enfin, j'ai manipulé cette variabilité phénotypique dans un dernier protocole expérimental de reconnaissance des visages afin d'évaluer son impact sur le BRE. Les résultats de cette dernière étude confirment également un BRE pour les stimuli africains et nord-africains dans une population européenne. L'impact de la variabilité intra-groupe sur la reconnaissance était relativement clair, en particulier pour les visages d'autres groupes ethniques.

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General Introduction

In 2001, Americans witnessed a notable television moment on "The View". The two presenters had received a letter from a fan congratulating one of the co-hosts on her journalistic work on the show and her acting in the film "Charlie's Angel". The journalist in question, Lisa Ling, had been mistaken for the actress Lucy Liu. Deciding to laugh about it, Lisa Ling and her co-host put on a slide show of the physical differences between herself and Lucy Liu and ended the presentation by saying that these confusions with other Asian personalities happened to her all the time. "I wish I could say it only happened with Lucy, but I ran the Boston Marathon last week and some people came up to me to congratulate me on my win. '*But I didn't win*', I said. '*Yes you did! We saw pictures of you !*' Once again, it wasn't me, but Lee Bong-Ju, a Korean …man." (Ling, 2001, 1:08)[1].

Although the journalist Lisa Ling may have decided to laugh about it, that was not the case for Samuel L. Jackson, who was rightly offended when, during an interview, the journalist confused him with another African-American actor, Laurence Fishburne. "You are as crazy as the people on twitter. That is Laurence Fishburne (…) We don't all look alike. We may be Black and famous but we don't all look alike. (…) you are an entertainment reporter and you don't know the difference between me and Laurence Fishburne?" (Jackson, 2014, 0:16)[2].

These repeated confusions may seem anecdotal and without significant impact, but they are a harsh reality for many people, especially those from certain ethnic groups. Beyond the annoyance and lack of recognition that this can generate, much more dramatic consequences can be associated with this phenomenon. For example, in 2012 a retired African-American tennis player, James Blake, was arrested for credit card fraud. The arresting officer thought he recognised the real suspect, also an African-American man, but in fact mistook him for Mr Blake. This case was widely publicised and critics on Twitter had called out the pervasive racism of the police. It would seem, however, that this phenomenon is not just a 'simple' problem of racism, and that the reality of it is much more important.

Mr Blake's story is far from an isolated case. According to the Innocence Project (https://innocenceproject.org) in the United States, these misidentifications of individuals in felony and misdemeanour cases may constitute a significant portion of US miscarriages of

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[1] The extract and anecdote can be viewed on YouTube at: https://www.youtube.com/watch?v=pt4ooJWwGwQ. This video is an extract of the show "The View" from April 2001.

[2] This extract can be viewed on Youtube: https://www.youtube.com/watch?v=OdxMkQhq58g. It is a video extracted from the interview of the Los Angeles morning show KTLA from February 2014.

justice. In 2022, the association restored the truth and cleared 375 cases of miscarriage of justice through DNA identification and exoneration. Of these cases, 69% involved eyewitness misidentifications, among which, 42% were exclusively related to inter-ethnic identifications. These cases have sometimes involved very long sentences, and some exonerees have been on death row for part of their mistaken imprisonment. These statistics give an indication of the impact of such a phenomenon on the justice system, but this is not the only area where difficulties of recognition and discrimination between groups can occur.

Indeed, these difficulties in inter-group face recognition could have a much more palpable impact for the majority of us: our social relationships. If one find it difficult to identify individuals within a particular ethnic group, it is likely to have a negative impact on our relationships with members of that group. In a social context where relations between ethnic groups are sometimes particularly tense, a recognition bias could contribute to the deterioration of social relations.

Ethnic group relations already suffer from pervasive conflict. The level of racism against African-Americans in the US and other countries has been made eviden by the '*Black Lives Matter'* movement. In a similar vein, one can point to the high level of discrimination against North Africans in France and the frequent conflation of radical Islamists with Muslims. Or again, the upsurge in violent behaviour towards Asians during the global COVID 19 pandemic attests to fragile inter-group relations. The existence of a visibly universal cognitive bias of face recognition in this context may catalyse inter-group conflict.

The phenomenon of recognizing members of one's own group with greater success than other-group members (and conversely, misidentifying outgroup members more often than ingroup members) is referred as the Own-Group Recognition Bias, which can also be found in the literature under other names such as "cross-race effect", "other-race effect" or "own-group bias". This bias has been studied for more than a century (Feingold, 1916), and has been the subject of a considerable number of scientific papers. In particular, the study of its potential origin has generated a very strong scientific interest. Theories abound, but two of them are recurrently put forward. The first postulates that the OGRB is an adaptive function of our cognitive system, which, when encountering more individuals from the same ethnic group, generally the one to which one belong, would specifically gear itself towards the recognition and discrimination of this ethnic group to the detriment of other groups. This explanation can be found in the concept of perceptual learning (or perceptual expertise), where our visual experiences define the abilities and, conversely, the limitations one have in recognising others (Sporer, 2001b). The second postulates that this bias is rather a function of social categorisation.

In this framework, it is postulated that individuals from other ethnic groups are perceived more through the prism of racial categorisation at the expense of more individualising information. In other words, individuals from other groups are defined by what they represent in terms of their ethnic/racial group and the encoding of identity information does not go beyond this (Levin, 2000)

One element to consider could be social interaction, as it brings both perceptual (expertise linked with exposure to faces) and social (individuation of individuals) benefits. Work in this area draws heavily on the literature on the Contact Theory (Allport, 1954). This theory highlights that prejudice and intergroup social interaction are strongly linked: the more prejudiced individuals are and the less social contact they will have, conversely the more social contact, the less prejudiced they will be (see Pettigrew & Tropp, 2006, for a review). The study of social interactions in the context of face recognition has been addressed in particular through the notions of quality and quantity of interactions (Hancock & Rhodes, 2008). In line with the relationship with prejudice, the more regular and positive social interactions individuals have with members of a particular ethnic group, the more effectively they will be able to recognise and discriminate against individuals from that group. More recently, authors have highlighted a gap between social interaction theory and the reality of the occurrence and context of intergroup social contact (Dixon et al., 2005). In particular, the notions of contact avoidance and intergroup anxiety have been suggested as important to consider in the objective of an ecological study of social contact.

So far, no clear consensus has been reached in the literature to present a single agreed theoretical accountof the OGRB. It is most likely that the origin of this bias is based on a combination of these elements and is not limited to any one of these explanations. it is also possible to identify elements for which there is little evidence that they are responsible for this bias. The idea that this difficulty of recognition is a function of racism, for instance, does not seem to be correct. It is a bias that is partly based on cognitive processes that affect all individuals. In particular, the OGRB has been presented as a very robust phenomenon whose effects are found in many contexts and cultures. However, it seems certain that prejudice is not totally disconnected from this recognition difficulty and could, through its link to social interactions, act as a mediator of face recognition. It also appears that the OGRB is not a function of some groups being more physically homogenous than other groups. Whether through genetic (Whiterspoon et al., 2007) or anthropometric (Goldstein, 1979) writings, it has been repeatedly demonstrated that no particular ethnic group is more homogeneous than another.

Another element to consider when looking at this bias is the within-group ethnic variability. Indeed, the OGRB is based on the notion of perceived difference between ethnic groups. However, what defines and constitutes an ethnic group is rarely defined in the literature. Meta-categories of individuals are presented, sometimes based on shared geography or national identity (e.g. "European"), sometimes on shared physical characteristics (e.g. "Caucasian") without considering the variability within these groups. The question of within-group variability and in particular what constitutes perceived ethnic typicality has been the subject of research but mainly in social psychology, and has not been studied in the OGRB literature to the best of my knowledge. In particular, the existence of an attitudinal bias activated by the perception of the ethnic typicality of individuals has been identified. This bias, called 'phenotypicality bias' (Maddox, 2004), results in the activation of prejudices, stereotypes and specific discriminatory behaviours in response to an individual's perceived ethnic typicality or representativity. In this framework, individuals perceived as particularly typical of an ethnic category will experience differential treatment, usually more discriminatory, than individuals of the same group perceived as ethnically atypical. This phenotypicality bias could be studied in conjunction with the OGRB, but it has not to my knowledge. A first point of convergence is the social components involved in these two biases, namely social interactions and prejudice. A second point concerns the understanding and integration of a more ecological notion of what constitutes an 'ethnic group'. The in-depth study of phenotypicality bias, and specifically the method of manipulating perceived ethnic typicality, could allow us to better apprehend the notion of 'group' in face recognition studies and better understand the potential impact of within-group variability on the OGRB.

This thesis is organised around two axes. The first focuses on the impact of social components on the OGRB. The second focuses on within-group variability and how it impacts both prejudice and the OGRB.

In the first part, I present a theoretical chapter addressing the different theoretical contributions to the understanding of the Own-Group Recognition Bias. In particular, I discuss its origins, and the social and cognitive components that underlie it. A particular focus is given to the notion of social interaction and how it might impact on face recognition. In a second chapter, I report an experiment on inter-group face recognition where I manipulated different social and cognitive factors. In particular, the aim was to test causal relationships between social contact, prejudice and interaction anxiety on the OGRB. Concomitantly, I investigated how the visual strategies employed during face encoding and recognition may underlie these relationships.

The second part of the thesis consists of two chapters. The first chapter focuses on a systematic review of phenotypicality bias and specifically how perceived ethnic typicality impacts ethnic prejudice. In the second chapter, I report a final experiment, in which I manipulated perceived ethnic typicality to assess its influence on inter-group face recognition.

Finally, I discuss the challenges, limitations and openings into new research of the entire theoretical and empirical work of the thesis.

Part I – The Own Group Recognition bias and Social Contact

Chapter 1 – Own-group recognition bias: cognitive and social components

Face recognition

Human face recognition: specificity and expertise

Face recognition is an important ability. We recognize other faces all the time, and this is probably a paramount function for our social life. A great deal of information can be inferred by just looking at a face: from attractiveness, likability, social categories (gender, age, socio-economic status, ethnic and -racial groups), to more specific information such as emotional state, intention and to some extent, personality traits (Little & Perrett, 2007). The human face thus conveys diverse and unique information to and from each of us. In fact, face processing is widely considered a specific form of visual processing, faces being processed differently from other objects (Yin, 1969; Diamond & Carrey, 1986; Valentine, 1988). Humans are known to be experts in recognizing and discriminating others (Baudoin et al., 2009). From birth, the brain is able to recognize in 130 milliseconds that a face is present in a scene (Jacques & Rossion, 2006), within the first 6 months of life infants are capable of differentiating a face from other objects (Nelson, 2001). This expertise also translates into a very quick ability to detect a familiar from an unfamiliar face. Discriminating and recognizing others is also robust across different light settings, viewing angles, perspectives, and to some extent, physical modifications and changes over time. This robustness is essential if we are to recognize the same individual in different contexts. Face recognition expertise is undoubtedly related to the social character of our lives and interpersonal encounters from an early age. But it must be underlined that this expertise is particularly strong for familiar faces, and less so for relatively unfamiliar faces. The recognition and discrimination of unfamiliar faces (seen just a few times) is much more sensitive to physical alterations and changes, and is thus easily disrupted. As a result, as we will see in more detail in the next few pages, unfamiliar faces are more prone to recognition errors and biases.

Model of face recognition

Despite the apparent ease with which one recognize familiar faces, face recognition is a very complex process. Several models have been developed to account for its functioning. One of the most popular contemporary models is the multidimensional face space (MDFS) model

introduced by Valentine (1991; Valentine et., al, 2016). This model was proposed to account for the representation of faces one have in memory. It was initially introduced to explain various phenomena related to face recognition such as distinctiveness and the inversion effect, but it has become a major tool for understanding face processing.

Valentine's model is based on the idea that each new face encountered in an individual's life will be encoded as a point in a face space along different dimensions representing physiognomic features (e.g., eye colour, mouth size, nose shape). Therefore, each individual has his or her own multidimensional model of faces, which depends on a history of personal visual experiences. It is assumed that the values accrued by encoded faces over a lifetime on these dimensions are normally distributed, varying around a central tendency, or norm. The ease and reliability of recognising a face already encoded in this space will depend on its location in space and in particular on its spatial position relative to other encoded faces. This model predicts that the more faces share similar facial features, the closer they are spatially in face space. Faces in the "average" population of a face, (i.e., sharing facial features commonly found in a population), are represented by points close to the norm and to each other, thus creating a face cluster. When retrieving information for these faces, there is a greater risk of confusion and therefore a greater difficulty in discriminating one face from another. In contrast, distinctive faces, (i.e., with fewer facial features shared with other faces), are represented in the face space far from the norm, more isolated from other faces. This distance from the majority of faces, and thus from the cluster located on the central norm, facilitates the recognition of these distinctive faces.

Two versions of the MDFS were developed. One is norm-based, where each face is encoded as a vector indicating the distance and direction from the central norm. This version of the model proposes an encoding where the norm is taken as a reference and each encoded face has an angle of deviation from the norm in the space. The second version is exemplar-based: each face is encoded without reference to a norm, but as a single point in the multidimensional space (Figure 1.1.)

Figure 1.1

Schematic representation of Valentine's MDFS
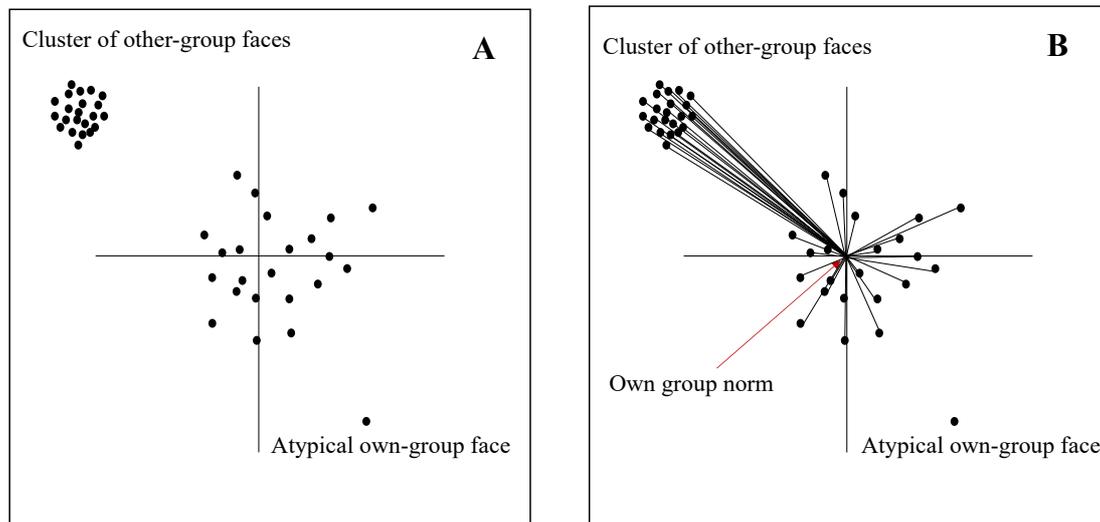
Note. Figure A represents the exemplar-based face model of own- and other-group faces. All faces are presented in relation to each other. The other-group faces are a distinctive cluster since they are represented with dimensions appropriate only for the own-group.
Figure B represents the norm-based face model of own- and other-group faces. Each face is represented according to distance from a norm (or prototype) that is more suitable for the own-group.

In each of these versions of the model, the distribution of faces in the multidimensional space is presented as heterogenous. As discussed above, the distribution of faces depends on the facial features present. The more typical the faces, i.e., with features shared by a majority of individuals (e.g., the nose more or less in the center of the face), the more these faces will tend to cluster around a single point (the norm in the normative version). Atypical of distinctive faces, on the other hand, are distributed more widely around this cluster. The norm-based MDFS version seems to be adopted more widely nowadays than the competing conceptualisation.

Valentine et al. (2016) report that each person's MDFS modulates itself according to visual exposure experiences. Faces encountered repeatedly and in different contexts will be encoded more deeply or elaborately in the model. Familiar faces will be better represented in terms of specific features, but also regarding existing dissimilarities with other faces. It is therefore easier to recognise a familiar face from an unfamiliar face, whose specificities and dissimilarities will be less obvious and therefore more easily confused with other faces.

Imperfect expertise

Face recognition expertise is not uniform (see Young & Burton, 2018, for a review) and one key element of difference in ability within individual is that occasioned in encounters between familiar and unfamiliar faces. Recognition of familiar faces plays an important role in social encounters and relies on the rapid retrieval of person-specific knowledge, such as semantic and emotional information (e.g., identity). These aspects may explain much of the difference between familiar and unfamiliar faces. Recognition of familiar faces is known to be mostly accurate, fast, easy and automatic. Young and Burton (2018) drew attention to the fact that face recognition expertise appears to be based on experiences for the same face in various contexts. Multiple representations of the same individual under varying exposures create recognition expertise. In contrast, one do not have the same expertise for unfamiliar faces, for which, by definition, exposure experience remains scant. This specification of face recognition expertise has important practical consequences and has been of great interest in applied settings.

Own-group recognition bias

Recognition of unfamiliar faces is less stable than for familiar faces, so it is more prone to bias and error. A well-known phenomenon, called the own-group recognition bias (OGRB) is one of the best known biases in face recognition. It can be defined as the difficulty in recognising and discriminating between members of other groups and one's own group (Malpass & Kravitz, 1969; Chance & Goldstein, 1996). Although it can also be present for other categories, such as age (Rhodes & Anastasi, 2012) or gender (Herlitz & Lovén, 2013), a significant part of the literature has focused on difficulties in recognizing members of other ethnic or 'race' groups. As early as 1914, Feingold referred to an experiential sense of higher similarity that one tend to have for individuals of another ethnic/racial group. He stated that this impression of similarity is directly related to our experiences of visual exposure to members of the group in question. Feingold postulated that individuals uninitiated with certain ethnic groups (i.e., having limited visual experience with that group) will be less able to distinguish one individual from another within that group. Although this phenomenon reflects the belief that other-group individuals tends to look alike, anthropometric analyses of different ethnic groups do not support this empirically (Goldstein, 1979). One could argue that the OGRB relies on higher similarities between individuals of the same group, thus making them more difficult to recognize one from another. In reality, no such differences have been shown (Shepherd & Deregowski, 1981; Goldstein & Chance, 1976), no group is characterized by more

homogeneous features. The OGRB is therefore not based on higher degrees of facial feature similarity of other-group faces to each other, but rather on a deficit of visual expertise in the perceiver, leading to a recognition bias.

In 1969, Malpass and Kravitz demonstrated the OGRB in an experiment for the first time. They showed that 'White' students in the US had better recognition abilities for 'White' faces than 'Blacks'. Since then, a considerable amount of research has been carried out; a meta-analysis published by Meissner and Brigham (2001) covering 30 years of research on this topic reported that an individual is almost 1.5 times more accurate at recognizing individuals from their own-ethnic group than others. Conversely, individuals are 1.56 more likely to mistakenly recognize individuals from other-groups as someone they have seen before.

The OGRB has also proven to be robust (Chance & Goldstein, 1996), with consistency across different research paradigms and populations. Although field studies are less numerous than laboratory studies, they generally show the OGRB to a similar degree (Brigham & Malpass, 1985; Platz & Hosch, 1988; Wright et al., 2001). Most attention in the literature on the OGRB has been given to recognition difficulties across 'Black' and 'White' groups, and in the meta-analysis of Meissner and Brigham (2001), 85% of studies focused on those groups. But other studies replicated the bias across various populations, such as Asian (e.g., Burns et al., 2018; Kloth et al., 2014; Valentine & Endo, 1992), Arab (e.g., Bataille, 2018; Brunet et. al, 2022; Hajji, 2018; Sporer & Horry, 2011) or South American (Latino) populations (Gross, 2009).

In many studies, better recognition for own-group faces appears to be symmetrical over groups: for example, 'White' and Black people may both be poorer at recognizing the other group than their own group (e.g., Ng et al., 2016). However, many studies show that the OGRB can manifest itself asymmetrically between groups, with the majority group typically being more prone to difficulty in recognizing other-group faces. A 2003 study by Wright et al., highlighted this asymmetry. They used a 'White' and 'Black' face recognition task to test 'White' English and South African participants and 'Black' South African participants. Both groups of 'White' participants showed an OGRB, but surprisingly, no own-group recognition bias was found for the 'Black' South African participants. The results even showed an inverse pattern with higher recognition ability of each group for the 'White' target faces. The authors stressed the importance of social contextual elements. In South Africa, although the 'Black' social group has numerically been in the majority since at least 1911 (the first official census), at the time of Wright et al.'s study it was a minority in the University from which the 'Black' participants were drawn.

The OGRB seems not to be inherent to the group itself, but depends on a temporal, spatial and political context, which may enable more or fewer visual exposure possibilities to a given group.

Development of the OGRB and 'perceptual narrowing'

It appears that the first year of a human's life is a crucial period in the construction of face perception abilities and the shaping of facial representations (see Kobayashi et al., 2018, for a review). It is now clear that the OGRB will emerge during this period. In line with earlier discussion, it seems that this recognition bias appears in relation to differential visual exposure to faces of different groups. Developmental studies support this idea and allow a better understanding of the conditions of development of the OGRB.

The OGRB is understood in the developmental literature as a phenomenon that appears very early in the life of any human. It seems to be a direct result of visual experiences that, from the earliest age, are predominantly with members of their own group (Sugden et al., 2014). It is postulated that infants, from birth, build up their ability to perceive faces independently of groups, and that they are equivalently able to distinguish a face from the own group or from other groups. This ability will be refined for own-group faces at the expense of those of other groups as a function of their perceptual history. This phenomenon has been reported under the perceptual narrowing hypothesis (see Maurer & Werker, 2014, for a review) which postulates that infants will gradually lose perceptual sensitivity for less frequent and unusual stimuli (such as other-groups) in favour of more frequent and habitual stimuli (own-group). Thus, a perceptual tuning will be set up towards the faces of one's own group, promoting a gain in expertise.

Kelly et al. (2007) studied a possible critical period in which infants are less able to recognise individuals from other groups. Their results suggest a progressive narrowing of discrimination abilities with age. Infants at 3 months of age show no differences in recognition of faces from other groups over those of their own group, but from 6 months of age, they are better able to discriminate faces from their own group. Other studies have suggested that the onset of the OGRB is more likely to occur at 3 months (Bar-Haim et al., 2006; Sangrigoli & de Schonen, 2004) or 9 months of age (Anzures et al., 2010).

A critical period for the onset of OGRB appears to occur concomitantly with the development of face perception between 3 and 9 months. This is a pivotal period when the baby's social environment will progressively tune perceptual abilities towards the faces of the

own group. In the majority of cases, individuals evolve from an early age in a social environment consisting of members of their own group. As a result, expertise for own-group faces will be developed, whereas faces from other groups will be more difficult to recognise and discriminate. Consistent with this idea, infants who are exposed to faces from other groups for a prolonged period of time should have no difficulty in recognising them. Sangrigoli et al. (2005) showed that Korean children adopted by European parents did not show the classical OGRB towards European faces but rather the opposite. This translates into difficulties in discriminating individuals of their own group (Korean) from those of the other group (European).

These developmental studies confirm that the OGRB is not an innate bias that automatically favours the group to which one belongs, but one linked to visual experiences and that the OGRB could even be reversed under certain conditions.

Theoretical accounts of the OGRB

The study of the OGRB has given rise to a large body of work, some of which has sought to find a theoretical explanation for the occurrence of this bias. As mentioned earlier, visual exposure seems to be a good candidate, but several authors have also invoked social aspects to account for the OGRB.

The perceptual expertise hypothesis

Most of the accounts of the OGRB in the literature fit into what can be called a theory of "perceptual expertise" (also called "perceptual learning"), according to which our perception of faces is shaped by our individual visual experiences. Exposure to individuals from the same group allows the acquisition of perceptual expertise for the faces in that group. This expertise will be less developed for faces from other groups because exposure to these faces is generally rarer. The acquisition of perceptual mechanisms and facial representations will therefore be adapted to the group of faces most frequently encountered in the social environment. (Brigham & Malpass, 1985; Chance & Goldstein, 1996). Consequently, when encoding and recognising faces from other groups, the strategies used are not adapted to the physiognomic characteristics of faces from other groups.

According to this hypothesis, individuals exposed to a significant number of members of another group will be able to acquire expertise for the faces of that group and thus reduce the effects of the OGRB (e.g., Sporer, 2001). As developmental studies indicate, the contribution

of visual exposure is particularly important during childhood and many adopted children show a weakening of OGRB in adulthood (de Heering et al., 2010; Wan et al., 2015, Study 5) or even a reverse bias, with better recognition of the other group than their own (Sangrigoli et al., 2005). Similarly, children raised in bi-racial families (e.g., 'White' and 'Black' family members) do not show the OGRB, and have equivalent abilities to recognise and discriminate between 'White' and 'Black' faces (Goodman et al., 2007). Furthermore, a study by Cross et al. (1971) showed that it is not only the family environment that can have an impact on OGRB: 'White' American children who grew up in an inclusive neighbourhood with 'Black' and 'White' Americans appear to have a milder OGRB than children living in a predominantly 'White' neighbourhood. Other studies have presented data on the mitigation of the OGRB in adult populations through the effects of visual exposure. In a 2014 study, Wiese et al., reported that expatriate Asians living in Germany showed better face recognition of the other group (in this case, European) than a control group of Asians living in their country of birth.

Further support for the perceptual expertise theory is to be found in the area of visual processing. The reason that repeated visual exposure with members of one group improves recognition and discrimination abilities for the faces in that group may be because it allows for an adaptation of visual focus to group-specific facial features that are critical for face recognition (Hills & Lewis, 2011). For example, it has been suggested that for 'White' observers, focusing on the upper area of the face will be a more effective scan strategy and therefore an adaptive strategy for recognising 'White' faces. Conversely, for 'White' observers, a more effective scan of 'Black' faces will be to focus on the lower area of the face (Hills & Pake, 2013). Other studies have added that the gain in visual expertise induced by repeated exposure would also lead to the use of more configural (or holistic) processes (Hancock & Rhodes, 2008; Sadozai et al., 2019). Finally, this explanation of expertise is also congruent with the multidimensional face space model of Valentine (2001). Specifically, the norm-based version was found to be particularly appropriate for explaining the OGRB. As expounded in this model, other groups' faces are encoded in terms of one's own group norm, which may be inappropriate. As a result, the faces of other groups are all encoded in terms of vectors pointing in the same direction, making it difficult to distinguish them from each other. Byatt and Rhodes (2004) tested this theory by combining a recognition task with an assessment of the distinctiveness of the faces being tested. As predicted by the MDFS, the faces in the other group were rated as more similar to each other, making them more difficult to distinguish. Conversely, the own group's faces were rated as more distinctive from each other and were therefore better discriminated.

Social explanation of categorization

Social psychologists have also entered this field of research and have elaborated an alternative (or addition) to the theory of perceptual experience. According to Sporer (2001), the OGRB is caused by a differentiation of the cognitive processes used, which is induced by a dichotomous categorisation of the stimulus as being 'own group' or 'other group'. Social psychologists remind us that people constantly categorise others as belonging to social groups (Bodenhausen et al., 2003). The Common Ingroup Identity Model of Gaertner et al. (1993) postulates that each individual belongs to a multitude of social groups. However, group membership can be fluid and may be more or less salient or important depending on context (Hogg & Turner, 1987). Categorising an individual as belonging to another group is not trivial; studies on categorisation have shown that it has adverse consequences on behaviour, motivation and cognition (Tajfel et al., 1971; Tajfel & Turner, 1986). The work of Rodin (1987) has added another piece to the puzzle, as categorisation into another group also has an important impact on the representation of the individual. To consider a person as belonging to another group would lead to a certain cognitive 'disregard'. Individuals from other groups are therefore seen more as representing a stereotype of their category, at the expense of individualising elements (Levin, 2000). On the other hand, individuals from the own group benefit from deeper cognitive processing, allowing them to acquire individualising (or individuating) information, which subsequently facilitates face recognition.

Several experimental paradigms manipulating social categorisation have highlighted a potential social source of OGRB. MacLin and Malpass (2001) devised a face recognition task in which they assigned hairstyles to "racially" ambiguous faces, creating faces perceived by participants to be typical of African-American or Hispanic-American groups. Apart from the haircut, the faces had a relatively similar base. Faces with an African-American haircut, and therefore categorised as such, were less well recognised by the Hispanic participants than faces considered to belong to their own group (those with a Hispanic haircut). Through this ambiguous racial face 'illusion', the authors argue that simple social categorisation could be one of the causes of OGRB. Indeed, this manipulation of grouping affinity appears to have had an impact on how faces were perceived by participants. For example, participants indicated that faces with an African-American haircut would have darker skin than others. This also had an impact on non-physical characteristics, such as the attribution of traits (e.g., warmth, distrust,

etc.). Similar results were obtained with children (Shutts & Kinzler, 2007) and with the attribution of stereotypical names of European and Asian origin (Hilliar & Kemp, 2008).

Following the same idea, Bernstein et al. (2007) demonstrated that in 'White' participants, for stimuli of 'White' faces, simple social categorisation was sufficient to lead to a recognition bias in favour of one's own group, regardless of whether the groups were real (university affiliation) or created specifically for the experiment (fictional personality categories). The results of the study by Bernstein et al. may suggest that the OGRB is not so much based on a notion of perceptual expertise but rather on a categorical perception, and the implications of that categorical perception. Social categorisation would lead to a perceveid homogeneity effect of the members of the group, disrupting the proper recognition of individuals' faces. As a result, the authors proposed that a focus on a social categorisation other than the one of the ethnic group (such as university affiliation in this context) would be sufficient to eliminate the OGRB.

To test this theory, Hehman et al. (2010) replicated the work of Bernstein et al. (2007) with a cross-group recognition task ('Black' and 'White') with 'White' participants. They associated each 'Black' and 'White' face with a university affiliation, either the participant's university (own group) or another university (other group). Their results showed a suppression of inter-ethnic recognition difficulties in favour of difficulties based on university affiliation. In other words, it is not so much the ethnic group that matters here as the University group, which, depending on the context, is more salient. Faces associated with another University group were less well recognised than faces from one's own university group (whether the faces were 'Black' or 'White').

As with the theory of perceptual expertise, the categorisation-based explanation of the OGRB has led to different explanatory models proposing categorization processes. Three main models can be mentioned. Levin (2000) developed a feature-based model in which the OGRB can be explained by a distinction made during encoding between own-group and other-group faces. Own-group faces are individuated by encoding relevant and useful facial features, while other-group faces are categorised by encoding features critical for such ethnic categorisation (e.g., skin tone). Therefore, no relevant features are encoded to distinguish and individualise the faces of one group from another. Sporer (2001) has developed an alternative model that complements Levin's model, named the in-group/ out-group model (IOM). According to Sporer, own-group faces benefit from a more individualising visual process, such as a configural (or holistic) process, which is a cognitively deeper and more efficient process. In contrast, the faces of other groups are processed more superficially, and this reflects the idea of

cognitive disregard brought up by Rodin (1987). Attentional focus is concentrated on categorisation elements and more limited resources are devoted to other elements of individuation. The ethnic group is taking into account from the encoding of face, as a result less focus is made on dimensions that would help differenciate individuals from each other. The processing of faces from other groups will therefore be more based on a featural process, a less efficient and less reliable process than configural processing. Finally, Hugenberg et al. (2010) elaborated the Categorisation-Individuation Model (CIM) in order to integrate the different social and cognitive types of explanation that are evident in the literature (many of which have been reviewed in this chapter). According to these authors, the OGRB is the consequence of three elements: perceptual experience, social categorisation and motivation to individuate. Social categorisation would cause a perceptual homogenisation of other ethnic groups. The motivation of individuation, on the other hand, would overcome the deleterious effect of social categorisation. Finally, the experience acquired with the faces of other groups would favour the accessibility in memory of information concerning this group. According to these authors, these three factors act in total interaction on face recognition capacities. In particular, they present motivation as an extremely influential and powerful force on categorisation and expertise. As outlined in the categorical model, individuals are inclined to spontaneously search for individual information for own-group faces. In contrast, individuals from other groups will be processed mainly on information oriented towards ethnic categorisation. According to this model, only motivation seems to be able to overcome the immediate ethnic categorisation from which the other group's encoding suffers. Experience alone cannot improve face recognition. A sufficient level of motivation for identification is necessary for expertise to develop.

On the whole, these social-cognitive explanatory models of the OGRB all suppose that perceptual experience is important, but are keen to qualify what moderates the effects of perceptual expertise. Without being totally exclusive (e.g., CIM), the social-cognitive models minimise, or even contradict, the effects of perceptual learning in favour of social categorisation. The OGRB would therefore not be the result of visual exposure so much as a predominant ethnic categorisation process that prevents an optimal individuation process. These models bring a social dimension to the explanation of OGRB that could complement the theory of perceptual learning. However, the categorical explanation has suffered from a lack of replicability in the literature of key studies. For example, Bornstein et al. (2013) were unable to replicate the negation of the OGRB by using the specific encoding instructions used in the study by Hugenberg et al. (2007). Similarly, Kloth et al. (2014) were unable to replicate the effects of bias negation by a re-categorisation of University affiliation, as presented in Hehman

et al. (2010). More recently, Harrison et al. (2020) failed to replicate Bernstein et al.'s (2007) findings on the emergence of recognition bias through simple categorisation.

Going beyond mere exposure: adaptation of the theory of contact

Although many authors agree that perceptual learning theory is convincing, it also has limitations. In particular, it remains to be determined whether repeated exposure alone is sufficient to justify the effect presence of OGRB. Indeed, Meissner and Brigham (2001), in their meta-analysis of the extant literature, reported a weak correlation between contact and the OGRB (contact explained only 2% of the variance). Two explanations have been suggested, the first is on the choice to use a correlation test, which implies that the relationship between contact and OGRB is linear, but this may not be the case. The second is based on a particularly important problem in this literature: the difficulty of assessing contact reliably. Meissner and Brigham (2001) noted that contact measures come in many forms and focus primarily on the amount of visual exposure.

Is the quantity of contact sufficient to account for perceptual expertise? A first point of reflection comes from studies showing an asymmetry in the impact of the OGRB. Under conditions where visual exposure opportunities are similar between groups, one should observe equivalent recognition ability between groups. However, as mentioned earlier in this chapter, some studies have shown asymmetry in the bias. In the case of South Africa, a country with a diverse population (including a 'Black' and a 'White' group), Wright et al. (2001) found an OGRB only for the 'White' group, whereas the 'Black' participants seemed to benefit from intergroup contact and showed equivalent recognition abilities for 'White' and 'Black' faces (see also Goodman et al., 2007). Thus, this study presents the fact that 'White' South-African individuals, whose visual exposure to South-African 'Blacks' should be equivalent to that of their own-group, did not acquire the same face expertise for Black South Africans. Despite the possibility of equivalent exposure to the groups, the OGRB is still present. It appears that other elements might come into play and these need to be considered in order to acount for this asymmetry.

Similar results were found by Chiroro and Valentine (1995) with a population of Zimbabwean students, in a school with roughly equal populations of 'White' and 'Black' students. Although the 'Black' participants showed an equal ability to discriminate and recognize 'Black' and 'White' faces, 'White' participants still showed an OGRB. The authors suggested that there may be a difference in the level of individuation between the students that could explain why, at equivalent levels of exposure, OGRB is still found in the 'Whites'. The

amount of visual exposure did not account for possible social interaction, which are essential for an individuation process to take place.

Snyder (1981) wrote as early as 1981 that to consider visual exposure as sufficiently powerful to explain the OGRB was to downplay intergroup relations and the social dimensions that follow from them. The effects of social contact have been widely studied in social psychology. In 1954, Allport presented the contact theory, which predicts a strong relationship between prejudice and social contact. Allport considered that when tensions arise between two social groups and prejudices are formed towards the other group, the best way to reduce these prejudices and resolve the conflict is to bring the individuals into contact with each other. Thus, social contact with members of another group, under certain conditions, is associated with a decrease in prejudice towards members of that group. This theory has been widely supported in subsequent research (see Pettigrew & Troop, 2006, for a meta-analysis of over 500 studies) and can be adapted to the field of face recognition. The appropriation of the Contact Theory allows us to consider contact beyond mere exposure and to introduce the interactional dimension of contact. The quality of social interaction appears to be specifically important in having a positive effect on attitudes (Pettigrew et al., 2011) and some studies on the OGRB tend to present similar results. Hancock and Rhodes (2008) designed a 'cross-group' face recognition task and assessed self-reported contact on dimensions of quality and quantity. Their results support the idea that the more regular and positive contact individuals have with people from other groups, the greater their ability to recognise faces from other groups. In an earlier study, Lavrakas et al. (1976) indicated that the quality of social contact may be even more consequential than the quantity of exposure for the development of the OGRB. The quality of social interactions can vary at different levels, depending on the nature of the relationship. For example, it is easy to see that a romantic relationship in contrast to a neighbourhood relationship will generate a higher level of quality of social contact. It is in the quality of these interactions that a process of individuation of the individual might take place. Work on intergroup relations has shown that members of one group tend to view members of the other group as homogeneous on many dimensions (Linville & Jones, 1980; Quattrone & Jones, 1980), even with increasing visual exposure (Linville, 1982; Park & Rothbart, 1982). Intergroup contact can have an impact on our perception of the other: positive social contact will likely help to reduce prejudice and perceived homogeneity of the other group, by giving the same kind of personal characteristics naturally attributed to members of one's own group (Rothbart & John, 1985).

On the one hand, repeated exposure allows for perceptual benefits and on the other hand, good quality interactions allow for individuation processes. Combined under optimal conditions, these cognitive and social elements of contact could help overcome the OGRB. More specifically, one of the advantages of social contact could lie in the enhancement of individuation processes, facilitating the process of individual face recognition from one encounter to another. This may help explain how social interaction can also impact on perceptual cognitive processes.

Social contact, OGRB and visual strategies

I have established that social interactions and repeated visual exposure to faces of a particular ethnic group appear to be particularly important in order to explain OGRB effects. It remains to be explained how contact reduces these difficulties. To answer this question, one can look at visual processing of faces and how repeated social interactions might modulate visual strategies. The OGRB reflects, as the name suggests, a difficulty in recognising other-group faces. Some authors have postulated that this recognition difficulty may be due to visual strategies that are less well adapted to recognising faces from other groups. An important sub-field in the face recognition literature uses eye-tracking measures to trace the visual strategies used during face fixation (e.g., Arizpe et al., 2016; Hsiao & Cottrell, 2008; Williams & Henderson, 2007). Eye trackers collects a lot of complex information such as the number, duration and scan path of fixations directed to specific areas of a face. The number of fixations, for example, tells us which information is encoded and which is not (e.g., a large number of fixations on the eyes but no fixation on the hair). A large number of fixations in a particular area of the face may indicate that this area gathered the most attention and was therefore better encoded. Fixation times may also be particularly important for studying the mental resources required to process information (Loftus, 1981). Longer fixation times have been shown to result in greater or more difficult information retrieval (Hooge & Erkelens, 1998; Jacob & Karn, 2003). When an individual is faced with complex visual information that disrupts automatic encoding patterns, more time is needed to achieve effective visual encoding. This can result in a longer fixation time.The scan path is a more complex datum that gives an idea of the order of fixations, for instance what was seen first and last, and the number of round trips between two areas, which may be important for understanding specific visual strategies (e.g., changes of focus from nose-to-mouth in a social interaction, etc.).

Several studies have shown that the eyes appear to be particularly important when looking at a face and generally attract the most fixations (Iskra & Gabrijelčič Tomc, 2019;

Laidlaw et al., 2012). However, there is an ongoing debate in the literature about the type of cognitive processes that underlie the type and effectiveness of group-dependent face scanning (e.g., Hayward et al., 2013; Levin, 2000; Meissner et al., 2005; Sporer, 2001; Valentine, 1991; Walker & Tanaka, 2003). In particular, there is some work on the use of configural rather than featural visual strategies depending on the group one is viewing. Faces from one's own group would likely be processed more holistically (as familiar faces) than faces from other groups (Blais et al., 2008; Hayward et al., 2008; Rossion & Michel, 2011; Tanaka et al., 2004). Some authors suggested that this difference in strategies could explain the OGRB (e.g., Michel et al., 2006) but other authors do not report the same results (e.g., Horry et al., 2015). There are also various predictions about visual strategies related to the consideration of the OGRB discussed (whether it is relying on perceptual expertise or an account that proposes categorisation processes). Accounts based on the perceptual expertise approach assume that all groups of faces are processed in the same way. Therefore, a model of visual strategies predominates, particularly well suited to the most frequently encountered faces, those of the own group. Conversely, this pattern of strategies may not be well adapted when encountering faces of individuals from other groups. This may partly explain the OGRB, if an individual does not implement the most appropriate visual strategies and pay attention to the most diagnostic features when encoding a face, it is likely that subsequent recognition abilities will be poorer. It has been suggested that focusing on the upper regions of a face would be more appropriate for 'Whites' while the lower area of the face would contain the most diagnostic information for 'Blacks' and 'Asians' (e.g., Ellis et al., 1975; Hills & Pake, 2013; Wang et al., 2015). In this context, training protocols for a group's most diagnostic facial features could counteract the OGRB. Although some visual attention training protocols show a decrease in OGRB (Hills & Pake, 2013), others do not show such encouraging results (Wittwer et al., 2019). In contrast, accounts based on a social-cognitive approach assume that in-group and out-group faces are not processed visually in the same way (Hugenberg et al., 2013). In particular, individuation processes that benefit own-group faces would lead to a greater focus on eyes compared to individuals from other groups, processed at the category level (Goldinger et al., 2009). As the eyes are a facial feature considered important, if not the most important, in processing a face (Caldara et al., 2010), the reduced visual focus on this part of the face for outgroup faces could explain the OGRB.

Although it is not possible to reach a consensus on the use of visual strategies across groups (see Stelter et al., 2021, for a review), there seems to be an element of non-adaptability of these strategies in the case of faces from other groups. Indeed, whether in predictions based

on the perceptual expertise account or on the social-cognitive approach, the conclusion remains that OGRB could be a result of using visual strategies not adapted to other groups' faces. The question is not so much whether faces are processed differently but rather whether the processed information is indeed relevant for a satisfactory encoding of a particular face group. Secondly, the studies presented so far do not, to my knowledge, provide evidence on the visual strategies used to process a North-African face, one of the populations of interest in this thesis. Most of the work in this area has focused on the potential differences between the visual scans used or the diagnostic features of European/'White' and African/'Black' and sometimes Asian faces. In the case of the existence of group-specific diagnostic facial features, it is therefore difficult to make accurate predictions about specific visual strategies for scanning North-African faces.

As discussed previously in this chapter, some authors have argued that visual learning of faces (i.e., their familiarization) can alter the visual strategies employed (Heisz & Shore, 2008). These changes are likely to improve face recognition (Elliott et al., 1973; Malpass, 1981). Indeed, holistic processing is known to be more effective for fast and efficient face recognition than featural processing. In a similar context, McKone and colleagues (2007) found that enhancing the presentation of individuals from another group by labelling these individuals as 'friends' promoted the use of holistic visual strategies and improved recognition of these faces.

It is therefore not easy to make predictions with certainty about the type of visual strategies employed when viewing other groups. However, one can agree that there is probably a mismatch in visual strategies when viewing members of other groups. The visual strategies used for the other group in particular would not be the most appropriate for effectively recognising members of these groups. It also appears that interacting with members of other groups, through the increase of face familiarity, may promote changes in visual strategies that are more likely to be appropriate for effective recognition.

Limits of social contact

Micro-Ecology of contact and avoidance

The study of the impact of social interaction patterns on the OGRB is the focus of this thesis. Although there is a significant amount of research in this area, the framework in which contact is considered has not received systematic attention. In order to provide a comprehensive approach to these effects and to propose a coherent empirical work, it seems important to outline the limitations of the study of contact.

As mentioned earlier, the study of social interaction in the OGRB draws heavily on studies of contact theory in intergroup conflict and the study of prejudice. The literature in this area has repeatedly highlighted the limitations of how social contact is conceived and evaluated. Dixon and colleagues (2005) published an article in which they questioned the reality of contact theory. They argue that the study of contact suffers from a disconnect with the reality of social interactions. In particular, they challenge social psychologists who consider contact only through optimal conditions, far from the actual contexts of interaction. Among the limitations mentioned is the nature of the content of intergroup interactions, which, beyond simple quantity or quality, may also be more or less superficial (Marsden, 1987) or in which certain topics will be avoided. Another limitation highlighted by Dixon et al. (2005) is the fact that there is often no spatial continuity between naturally occurring groups to allow for social interaction. One should note the spatial organisation of homes, schools and workplaces that often remain segregated between ethnic groups[3]. The possibilities for interaction between groups are therefore made difficult from a very early age. On the other hand, several studies show that even in shared spaces where various groups are present, there are still boundaries between the groups and thus no contact between them. This last element has been discussed in a body of work called "contact micro-ecology", which aims to describe the pattern of interaction between ethnic groups in different ecological contexts. In particular, there is a body of observational data on interaction behaviour on beaches (Dixon & Durrheim, 2003), but also in universities and public schools in their cafeterias, playgrounds and classrooms (Alexander & Tredoux, 2010; Clack et al., 2005; Dixon et al., 2008; Koen & Durrheim, 2010; Tredoux et al., 2005). Another type of study, based on an experimental approach borrowed from Garfinkel's (1967) breaching experiments, studies the behaviour of groups when choosing a seat in an ethnically mixed university dining hall (Alexander, 2007). All these observational studies come to the same conclusion: social interactions between groups, even when facilitated by a common spatial context, are often, and perhaps typically avoided. This avoidance of contact, which seems to be a recurrent event in ecological situations, has however rarely been taken into account in the study of social interactions. Work in this area has largely focused on the occurrence and valence of contact and how it may reduce prejudice and has rarely considered the impact of missed opportunities involved in contact avoidance.

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[3] This must of course be seen in the context of each country. In the French context, a general segregationist space is more difficult to assess, in part because ethno/racial statistics are not legally permitted.

Friendship and negative contact

More recently, work has also shown a strong focus on the notion of positive contact in this area, at the expense of negative one. Indeed, studies of contact patterns in the contact theory literature have over-invested in the occurrence of positive contact, such as friendships. This makes sense in relation to Allport's (1954) optimal contact conditions[4], according to which contact is effective in reducing prejudice if it meets certain criteria. However, it appears that intergroup friendships are not as common as within-group friendships, which is partly consistent with the findings of the 'contact microecology' studies. Stearns et al. (2009) report in their study of friendship networks of 'Black' and 'White' individuals that they are generally ethnically homophilic. Similar findings have been replicated in other populations (Schrieff et al., 2010; Tredoux & Finchilescu, 2010) and have been found to be particularly strong for 'Black-White' friendships compared to 'White-Asian' and 'White-Hispanic' friendships (Fischer, 2008). Within-group friendships also appear to be of higher quality than those between groups (Graham et al., 2009). It is therefore important to report on the reality of intergroup friendship, which, although effective in reducing prejudice, is in fact not very common. This also poses a new limitation to the study of contact. While intergroup friendships have been repeatedly highlighted as essential for reducing prejudice, it remains important to understand how negative contact can also have an impact on these negative attitudes. It is clear that social interactions between groups are not always positive. The many conflicts, strained relations between groups and racism are an example of this. Therefore, some authors have stressed the importance of studying the potential effects of negative contacts in this area as well. In particular, Barlow et al. (2012) reported that negative contact is more strongly correlated with prejudice and discriminatory behaviour than positive contact. Other authors have not replicated these findings, concluding that positive contact remains a better predictor of prejudice (Christ et al., 2008; Pettigrew & Tropp, 2011, Chapter 12). Still others suggest instead an interaction effect between the two types, where positive contact mitigates the effects of negative contact and, conversely, negative contact reinforces the effect of positive contact (Arnadottir et al., 2018). Given its effect on prejudice, and because negative contact appears to be a better predictor of contact avoidance than positive contact (Hayward, 2016), it seems important to

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[4]   Namely, equal status, possibility of knowledge, intergroup cooperation (common goals) and support of authorities, law or customs.

consider negative contact in the study of social interactions, if only to reflect the reality of social interactions in a more ecological way.

In the light of the work cited above, it seems necessary to maintain vigilance in the way contact and intergroup interactions are studied in social psychology. If recurrent and positive contact has shown its effectiveness in the study of prejudice, it seems important not to limit ourselves to utopian conditions of contact and to consider other aspects of interactions such as negative contact and contact avoidance. These recommendations in the study of contact are also applicable to the study of face recognition. Indeed, in the appropriation and adaptation of contact theory to explain the emergence of the OGRB, one find a reproduction of these utopian conditions for studying social interactions.

Avoidance behaviour and anxiety of interaction

Why do we avoid contact ?

I have established above that there is a gap between the sometimes utopian way in which contact has been studied in social psychology and the ecology of the occurrence and settings of intergroup interactions. The reality of significant contact avoidance raises an important question: why is intergroup contact generally avoided? In a mixed methods study, Finchilescu et al. (2007) asked 'Black' and 'White' individuals about their reasons for avoiding contact with members of the other group. Two latent dimensions were extracted from these results. The first is blaming the other group for not wanting to mix (the authors call this the 'blame' dimension) and the second is justifying this avoidance on the basis of too many differences between the groups (the 'difference' dimension). In another mixed method study using the focus group method, Schrieff et al. (2010) made an important point. Their participants revealed that ethnically homogenous spaces would be experienced as more comfortable and safe. Conversely, entering spaces occupied entirely or largely by other groups would be more unpleasant due to the anticipation and fear of potential rejection, confrontation or negative interactions with members of the other group.

Anxiety of interaction

This notion of fear of confrontation and negative contact raised in Schrieff et al.'s focus groups is illustrated by the anxiety-provoking reality of group interactions highlighted by Richeson and Shelton (2007). Interaction with an individual from another ethnic group has been shown to cause discomfort and distress to its protagonists (Vorauer & Kumhyr, 2001). As to

the reasons for this interaction anxiety, the evidence is not clear. Intergroup anxiety has been defined by Stephan and Stephan in 1985 as the ambiguous feelings of discomfort or anxiety when interacting with members of other groups. In 2000, Stephan and Stephan presented an integrated threat theory model where they postulated that intergroup anxiety is intimately related to threat perception. Specifically, in Stephan and Renfro's (2002) revised model, negative attitudes will increase threat perception, which, in turn, will trigger psychological and behavioural responses, including feelings of intergroup anxiety. This feeling will influence our ability to interact and may produce specific behaviours, such as avoidance of social interactions anticipated as negative, unpleasant, threatening or even confrontational. Interaction anxiety may therefore partly explain these contact avoidance behaviours, and some work has investigated how it affects the relationship between contact and prejudice. In a 2008 meta-analysis, Pettrigrew and Tropp presented a contact-prejudice mediation model according to which social contact, under specific conditions (mainly quality and quantity), helps to reduce anxiety and negative emotions such as anger, fear or feelings of threat. The reduction of these emotions could in turn allow the reduction of prejudice and the promotion of positive emotions (such as empathy) in favour of the other group. They also pointed out that intergroup anxiety is a significant predictor of contact avoidance. Besides, in studies measuring psychophysiological changes, intergroup contact has been shown to be related to indictators of anxiety (Amodio, 2009; Littleford et al., 2005)

This anxiety about intergroup interactions could also be accentuated by the OGRB itself. Indeed, difficulty in recognising members of other groups could also be a barrier to social interactions. Difficulty in recognising faces has an impact on both perceivers and perceived individuals. On the one hand, perceivers who are unable to recognise individuals from other groups may have difficulty initiating a conversation on a second encounter, a feeling of ambiguity and discomfort in discriminating against someone may impact on the intergroup relationship. On the other hand, individuals perceived as belonging to another group may feel insulted at not being recognised, thus increasing the perceived differences between the groups and adding to the discomfort in intergroup relations. For both protagonists, intergroup interactions will therefore be potentially anxiety-provoking and may lead to avoidance strategies. Furthermore, in an unbiased process of recognising individuals, one is able to associate semantic and individualising information with each person. A correct association between an individual's physical characteristics (his appearance) and semantic information (e.g., his name is Bob) can create a specific social relationship with that individual over interactions. In the case of individuals from other groups, there is a disruption in the processing

of physical characteristics. One is not able to distinguish this face as 'familiar' (already seen) from another face belonging to the same group. Thus, one is unable to associate the semantic information potentially associated with this individual, which makes an individuation process impossible. Stephan and Stephan (1985) argued that the fear of not being able to correctly identify or individuate individuals could increase intergroup anxiety, and thus the discomfort of intergroup interactions. Brigham and Malpass (1985) confirmed this and argued that misidentification could also increase intergroup hostility, distrust and stereotyping. Under these conditions, it is understandable that establishing a social relationship between two individuals from different groups can be difficult, especially in the early stages.

Although it is difficult to give a clear answer to the question of why contact is avoided, it seems that issues of interaction anxiety are important to consider. Earlier, I discussed the role of interaction anxiety in the study of the relationship between contact and prejudice and showed it to be an important element. Furthermore, it is still relevant to the study of contact, apart from its potential role as a trigger for avoidance behaviour. When group interactions are not avoided, and therefore do occur, they remain anxiety-provoking. This is an important consideration in the study of contact. Finally, we have seen that the recognition difficulties from which the OGRB arises could partly explain this interaction anxiety. All of this points to a close relationship between interaction anxiety, avoidance behaviours, social contact patterns and face recognition, which will therefore be considered together in this thesis.

Prejudice

In this last part I will discuss the notion of prejudice and how it will be integrated in this thesis. Prejudice has already been discussed many times in this chapter. It is difficult not to mention negative attitudes when dealing with intergroup relations. However, prejudice as a predictor of interest in the OGRB study remains more rare. The approach and genesis of the own-group recognition bias that is studied in my work is based on social interactions. As exposed, social contacts would bring perceptual (repeated exposure in many contexts) and social (individuation) benefits. In these last pages, I have tried to take a critical look at the conception of social contact and to consider the different elements to be integrated in its study in order to approach the reality of intergroup relations. In this context, the integration of a measure of prejudice seems important.

Prejudice has sometimes been tested directly as a predictor of OGRB. The hypothesis that attitudes towards a group are predictive of OGRB is not new and was, in fact, one of the

first elements invoked by social psychologists to explain the OGRB. In 1973, Galper suggested that prejudice is a good predictor of OGRB strength, and more specifically, he suggested that high levels of prejudice towards a particular group would present a higher level of OGRB for that group. To explain this effect, Carroo (1987) suggested that negative attitudes would lead to a greater focus on stereotypical group characteristics rather than individual characteristics, which would explain the greater difficulties in discriminating and recognising people from other groups. He had also suggested a more indirect relationship with contact theory, according to which prejudice is an indicator of experiences with other groups, which is itself known to be a predictor of recognition difficulties. However, this assumption of a direct relationship between prejudice and OGRB was not always conclusive in the literature. Much of the literature does not show such a relationship (e.g., Brigham & Barkowitz, 1978; Lavrakas et al., 1976; Platz & Hosch, 1988; Slone et al., 2000; Swope, 1994; Yarmey, 1979).

In a 2001 study, Ferguson et al. proposed that one reason for the lack of significant results could be the method of collecting attitudes (direct and self-report). They therefore employed a task measuring face recognition of other groups, with direct and indirect measurement of prejudice (self-report and IAT scales). Their results were unexpected. Negative attitudes had an impact on recognition performance, but in a similar way between the own group and the other group. Thus, individuals with high levels of prejudice had more difficulty recognizing faces from all groups combined than individuals with low levels of prejudice. Although this study does not exactly support Galper's predictions, it seems to provide a useful approach to the potential link between prejudice and OGRB. Later, Lebrecht et al. (2008) found a link between implicit racial bias and recognition bias. In a study on individuation training, they showed that training concomitantly reduced OGRB and implicit racial bias. More recently, a study examining the relationship between implicit prejudice (as measured by an IAT) and OGRB seems to show that implicit prejudice positively predicts the OGRB (Trawiński et al., 2021). According to these authors, the greater an individual's attitudinal prejudice towards his or her ethnic group, the greater the difficulties of recognition towards another group. These three studies suggest that there is a relationship between attitudes and face recognition performance, especially when implicit measures are used. As for evidence of a link between explicit attitudes and OGRB, one conclusive study, conducted in a French context, can be cited. In 2002, Py and Burdairon demonstrated that the level of explicit prejudice is a direct factor in OGRB for 'White' participants. Through two studies using 'White' and 'Black' stimuli (Study 2) and 'White' and North-African stimuli (Study 3), these authors demonstrated that the level of prejudice has a negative impact on the ability to recognize other groups.

From the studies reviewed on this specific question, it is not possible to determine with certainty whether prejudice has a direct impact on own-group recognition bias. While some authors seem to find significant effects of these attitudes on recognition performance, especially using implicit measures, others have not reached the same conclusion and present the absence of such a relationship. In any case, and as discussed by Caroo in 1987, it is possible that prejudice does not have a direct role on OGRB but rather acts as a moderator via social interaction experiences. Indeed, as highlighted by contact theory (see Pettigrew & Tropp, 2008, for a review), prejudice is strongly related to social contact patterns. Prejudice will therefore be included as a variable of interest in this thesis, given its potential direct effects on the OGRB but especially its strong link to social interaction patterns.

Conclusion

In this theoretical chapter, the existence of a face recognition bias favouring one's own group or ethnicity has been highlighted. Several theoretical approaches have been developed to characterise the emergence of this bias. One of them consists in considering social contact as a major element explaining the difficulties of intergroup recognition. Social interactions have both cognitive and social contributions that seem to significantly improve our ability to recognise individuals. In this context, social contact, under optimal conditions of quantity and quality, is considered to be related to less difficulty in intergroup recognition. One avenue of research concerning the effects of contact on face recognition is the modulation of visual strategies. The literature tends to show differences in visual strategies depending on the ethnicity of the person being observed, with less adapted and less effective visual scans for individuals from other ethnic groups. Optimal social interactions could modify these visual strategies, especially for individuals from other ethnic groups, to make them more adaptive and thus improve their recognition and discrimination. However, I have also established that the conceptualisation of contact needs to be done with care. I do not question the large amount of research attesting to the relationship between good quality of social contact and both prejudice and OGRB. But, the literature on contact theory has been assessed as suffering from a gap in reality and research on the 'micro-ecology of contact' has highlighted some key sub-components of contact that need to be taken into account. In particular, I have highlighted the importance of considering negative contact but also interaction avoidance behaviour. This more ecological approach to social interactions could also benefit from the contribution of other components revolving around social contact. One of these is prejudice, which, while not the only predictor

of social interactions (Zuma, 2014), is nevertheless particularly important to consider. The second is the anxiety-provoking reality of social interactions, which also helps to understand the avoidance behaviour observed between groups.

I have presented the various links in the literature between these different social and cognitive components. What emerges is a chain of interconnected effects that may be particularly important for understanding the OGRB. According to this idea, the low quantity and quality of social contact with members of another ethnic group may increase anxiety towards these members, leading to contact avoidance. This can be expected to increase prejudice and difficulty in recognising the faces of members of the other ethnic group. This chain of effects can also be viewed from several angles: one could be that difficulties in recognising members of other ethnic groups are a barrier to making contact, which increases anxiety about interacting with a member of another group, thus implying poor and infrequent contact, which in turn leads to increased prejudice. In order to study the different main and interaction effects that could take place between all these components and in particular on face recognition, I propose an experimental study preceded by the creation and testing of materials. Firstly, it is necessary to make an inventory of existing tools to assess the modes of social contact and prejudice. A social interaction scale was created and tested, accordingly, in order to account for ecologically sensitive varieties of contact. For this purpose, particular attention was paid to items assessing interaction or contact avoidance. Then, a second scale, in French, was also created and tested, adapted to the current context and partially oriented towards the evaluation of prejudice towards North-African individuals, although an adaptation for other groups is possible. In the main study, I report a complex exploratory experimental protocol, combining the different components of interest mentioned above, while measuring visual strategies.

Chapter 2 – Experimental work: OGRB, social components and visual strategies

Overview

Based on the review presented in the previous part, I reported, in this present chapter, an experiment on cross-group face recognition including the study of the different social and cognitive components. As the study was conducted in France, I organised my experiment with a 'White' European population using 'White' European (own-group) and North-African (other-group) stimuli.

Multiple objectives were targeted for this study. The main one was to evaluate how social contact can modulate cross group face recognition. Considering the literature on contact and the OGRB, and in particular the study of the micro-genesis of contact, particular attention has been paid to the way in which patterns of social interaction were assessed. Therefore, I investigated a measure of self-reported contact including dimensions on quality of contact (positive and negative contact), quantity of contact, and contact avoidance. This last dimension is particularly important since it has only very rarely been included in previous OGRB studies. In this approach of assessing contact beyond simple measures of quantity and quality, I also investigated the concomitant study of the level of prejudice towards North-African individuals through a self-report scale dealing with conative and affective aspects of prejudiced attitudes. Then, still in this principle of the extended study of contact, I included a manipulation of inter-group interaction anxiety, which is known to be important when groups have contact. In addition, and in order to better understand the cognitive effects of social contact on face recognition, this study also assessed face scanning strategies through measurement of eye movements.

In order to achieve these objectives, European participants were required to complete a face recognition task in which they attempted to recognise 'White' European and North-African individuals. During the encoding of faces, I introduced social interaction with one member of each group on an instant messaging service. Those social interactions were made mor or less anxiety-provoking in three between-subject experimental conditions (operationalized by varying the emotional expression of stimuli and the quality of social interaction). This interaction anxiety was measured through various self-report measures of anxiety as well as physiological arousal. After the recognition phase, the participants were asked to complete a scale assessing self-reported social contact patterns with North-African individuals, and a self-reported scale assessing prejudice towards North-African individuals. During the encoding and

recognition of faces, visual strategies (the number of fixations and the dwell times) were measured with an eye-tracker.

Hypotheses

Manipulation check of interaction anxiety induction

One manipulation during this experiment concerned the induction of different levels of anxiety of interaction. To begin with, I expected to be able to replicate the findings in the literature that social interactions, particularly with an individual from another group, cause interaction anxiety (Vorauer & Kumhyr, 2001). As such, I expected an increase in participants' interaction anxiety between the start of the experiment and the interaction periods, and that this effect would be even stronger if anticipating interacting with a North-African compared to a European person.

I also expected that the interaction anxiety manipulation implemented in this experiment, i.e., the use of stimuli with different emotional expressions (threatening, neutral and friendly) combined with a specific interlocutor attitude (unpleasant, neutral or pleasant) would be associated with different levels of interaction anxiety. The condition in which faces were presented as "angry/threatening", accompanied by an unpleasant interlocutor, should have generated greater interaction anxiety than the neutral and "friendly/happy" conditions. Conversely, the "friendly/happy" condition in which faces were presented as "smiling" and the interlocutor as "pleasant", was expected to decrease interaction anxiety compared to the neutral condition and even more so compared to the 'threatening' condition.

This manipulation was checked with both physiological measures (pupillary dilation and heart rate variability) and a self-reported measure of anxiety (STAI -Y, Spielberger et al., 1983).

Hypotheses on social contact pattern and prejudice towards North-African individuals

I postulated that social interaction and prejudice towards people of North-African origin should show similar patterns.Given the extensive work on contact theory (Pettigrew & Tropp, 2006), I expected that prejudice and contact patterns would be correlated. In particular, I expected prejudice to be negatively correlated with the quantity and positive quality of social interactions. Conversely, I expected prejudice to be positively correlated with contact avoidance and negative quality of social interactions.

Then, I expected contact avoidance and negative quality of contact to be negatively correlated with the quantity and positive quality of contact.

Hypotheses on face recognition performance

I was expecting to replicate an OGRB, i.e., a better recognition of the faces of the own-group (Europeans) compared to the faces of the other-group (North-African). (H1)

I also expected to observe the effects of social contact patterns on the other group's face recognition performance. Specifically, I hypothesised that individuals with good quality and high quantity contact patterns would perform better in recognising individuals from the other group compared to participants with sparser and more negative interaction patterns (Hancock & Rhodes, 2008). (H2)

Similarly, I expected to observe an impact of interaction avoidance behaviours on the recognition performance of North-African individuals. I had postulated that individuals who strongly avoid contact with this group would have poorer recognition abilities of North-African faces than those who do not avoid contact. (H3)

Then, I assessed the possibility that prejudice was moderating the effects of self-reported social contact on the OGRB. I was expecting that high levels of prejudice and low levels of contact[5] would be associated with lower recognition performance on North-African stimuli. Conversely, I was expecting that low levels of prejudice and high levels of contact would be associated with better ability to recognize North-African individuals. (H4)

Other expectations concerned the impact of the social interaction manipulation during the experiment. I wanted to test whether at a very early stage of a social relationship, in this case the first social interaction, it was possible to observe the '*genesis*' of contact effects, as an embryonic individuation process (Rothbart & John, 1985). It was postulated that stimuli encoded with social interaction would receive better recognition than individuals encoded without interaction. It was expected that this effect would be stronger for North-African compared to European stimuli, that should be recognized accurately regardless of the manipulation of contact. (H5)

It was expected that there would be a moderation effect of the interaction anxiety and prejudice on this '*genesis*' of contact. I specifically hypothesised that the positive effect of

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[5] Low contact refers here to low quantity and positive quality score of self-reported contact, and conversely high level of negative quality contact and avoidance of interaction.

social interaction on face recognition performance would be stronger in the happy/friendly condition than in the angry/threatening condition. (H6)

Similarly, I was expecting that the positive effect of social interaction on face recognition would be stronger for individuals with low prejudice in comparison to individuals with high level of prejudice. (H7)

Hypotheses on visual stratregies

As a first step, I expected to observe differences in visual scanning according to the ethnic group of the stimulus faces as a function of defined Area of Interest (uper-part versus lower-part of the face). As sometimes presented in the literature, European participants were expected to process faces from their own group differently from those of the other group (e.g., Blais et al., 2008). Although I expected a greater focus on the upper face for both groups of stimuli, it was expected that European stimuli would receive greater visual focus on the upper area of the face than North-African stimuli. Conversely, North-African faces were expected to receive greater focus on the lower area of the face than European faces. (H8)

In a second hypothesis, I postulated that social contact might impact visual strategies for North-African stimuli. I expected this effect of social contact to be observable through both types of contact in this study: self-reported patterns of interaction and manipulation of contact during the experiment.

Regarding self-reported contact, I expected to replicate some of the literature on this topic, i.e., differences in visual strategies employed according to contact level (McKone et al., 2007). In particular, I expected visual strategies to more closely resemble the strategies used when analyzing faces from one's own group for participants with high levels of contact compared to individuals with low levels of contact. Those include both avoidance and social contact pattern. In other words, I was expecting that individuals with high levels of contact and/ or low level of avoidance would focus more on the upper area of North-African faces than people with low levels of contact and /or of avoidance. (H9)

Regarding the manipulation of social contact, the same pattern of results were expected. I was expecting that North-African faces encoded with social contact would elicit different visual strategies than faces encoded without social interaction and this would result in better recognition for those stimuli. In particular, I was expecting than those faces would elicit greater focus on the upper part of the face, as one can see for European faces, compared to North-African faces encoded without contact. (H10)

Finally, effect of manipulated social contact was expected to be moderated by the anxiety condition. The modulation of visual strategies was expected to be greater in the "friendly/happy" condition than in the "neutral" condition, which in turn was supposed to present higher modification of visual strategies with contact compared to the "anger/threat" condition. (H11)

Method

Participants

A pre-test was carried out on 10 participants in order to check the correct set up of the different tasks and to calibrate the recording procedures of the physiological measurements as well as possible.

A sample of 121 European students participated in this experiment, 33 of them were excluded from the final analyses for various reasons (technical problems, non-European ethnic origin[6], and non compliance with the instructions during the test). The final sample therefore consisted of 88 participants, 82 women and six men (M_{age} = 23.09, SD_{age} = 6.08) distributed into two groups of 28 and one group of 32 participants. The implications of these sample sizes will be discussed later.

Material/Equipment

Experimental setup

The experiment was implemented using two desktop computers and one tablet computer. One computer with a 21-inch screen was used for the encoding and recognition phases, and this computer was also us ed to record eye-tracking data.

A second computer was used to present the contact phases and the distracter task. Virtual discussions were conducted via the Slack Technologies virtual communication platform (Slack Technologies, San Francisco, CA), where two instant messaging windows were presented named "discussion1" and "discussion 2". The distracter task was a crossword to be completed virtually in 20 minutes, on a website (https://www.20minutes.fr/services/mots-croises).

An Ipad (Apple, 10.2", 2019) was used to collect consent forms and the different questionnaire scales used in the experiment (STAI, prejudice and contact scales).

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[6] The self-reported phototype and country of birth of grandparents were used to estimate the ethnic affiliation of our participants. Individuals with at least 2 grandparents from outside Europe and/or a phototype higher than 4 were excluded from our analyses in order to have a European population.

Eye tracking

The eye-tracker was used to account for visual strategies and the dilation of pupils was taken as an indicator of physiological arousal. The device used was a mobile SMI Red 250 (SensoMotoric Instruments) with an optional manual Smart Binocular calibration with a sampling frequency of 250 Hz and a distance of 60 cm from the screen. This distance was controlled through this experiment via a chinstrap. The software used to design the experiment was Experiment Center 3.6 (SMI, SensoMotoric Instruments). The eye-tracking data were extracted via BeGaze 3.6 software (SMI, SensoMotoric Instruments).

Heart rate variability

Heart rate variability was measured in order to account for arousal changes, such as anxiety. It was measured via an electrocardiogram with an actichamp® amplifier with a sampling frequency of 500 Hz. The software for recording it was BrainVision Recorder 1.21 (©Brain Products GmbH, Gilching, Germany). The electrocardiogram data were extracted in two steps; heart rate peak was extracted under Matlab (version 7.10.0) via the algorithm of Tomkins (1985), and final calculation with the different HRV indicators was done on Kubios HRV.

Face stimuli

108 colour images (1280 X 720 pixel resolution) of men (front view), 54 of European origin and 54 of North-African origin, were used for this experiment[7]. These were divided into three sets of 36 photographs according to their emotional expressions: neutral, angry and happy faces. Images were modified using Photoshop (version 2020, 21.x) for standardization purposes: the visible body part below the neck was erased, the faces (including hair) was aligned on a template diagram, using the eyes and nose, and the background was standardized to a neutral grey scale. A second transformation which consisted of transforming the face images to greyscale was carried out for the stimuli used in the recognition phase so that the task was one of face recognition and not merely picture or image recognition[8].

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[7] Photographs were selected from the Radboud University database from faces labelled as 'Caucasian' and 'Maghrebian' (Langner et al. , 2010)

[8] The transformation into grey scale should partly counteract recognition of face images by picture cues rather than face characteristics. However, this is not ideal, the literature suggests to rather use photographs taken from a different viewpoint. However, in the database chosen, no other views for our three different emotional expressions were available.

Social interaction manipulation

Social interaction consisted of speaking with an accomplice of the experimenter and not the people seen in the photographs. I created two different profiles of men, with different characteristics (age, study, place of residence, and hobbies) in order to standardize interactions as much as possible by giving them a common base. The social interaction was implemented via online messaging.

In the same vein, instructions were given to the accomplice in order to modulate her behaviour with the participant as a function of the experimental group (angry, neutral or happy).

Self-reported measure of anxiety

This measure was used to assess the anxiety state of the participant during the experiment.The State Trait Inventory Anxiety scales (STAI-Y, B) from Spielberger (1983), translated and adapted in French by Gauthier and Bouchard (1993) was used and completed on an Ipad at different stages of the experiment (Appendix A).

Prejudice and contact with North-African individuals

Lastly, two scales were developed in order to measure prejudice and contact with North-African individuals. In planning the study, it was clear that quantity and quality of intergroup interaction was important to measure. Besides, numerous scales are available in the literature to do so. However, there was no satisfactory measure tool for the avoidance of contact, being of less interest in the literature. Prejudice was also likely to be important for this study, but considering the fact that the participants were French and the target group North-African, I could not find an adequate tool to measure prejudice. Therefore, I created and tested two scales. In order to do so, the items created were tested in two steps consisting of a first collection of data and the testing of the internal structure of the questionnaires via an Exploratory Factor Analysis (EFA). Then this structure was confirmed on a second collection of data with a Confirmatory Factor Analysis (CFA). A summary of the process is available below but a full report constituted of a rationale, complete method, analysis and discussion is available in Appendix B.

Scale development

Concerning the contact scale, I oriented the creation of the items around three main dimensions: quality (positive and negative), quantity and contact avoidance. The items dealing

with the first two dimensions were created by translating and adapting pre-existing items in the literature, the complete list of which is available in Appendix C. The contact avoidance items are original or inspired by the unpublished work of Durrheim et al. (2012).

For the prejudice scale, I based the construction of the items around two of the standard dimensions of attitudes: conative and affective. To satisfy the first I gathered items on adhesion to discriminatory behaviour, for the second on appreciation of the North-African culture or for North-Africans in general. Here again some items were translated and/or adapted from the literature and others are original; a detailed list is given Appendix D.

These first two scales contained 52 items in total, 24 for the contact scale and 28 for the attitude scale. Each item was associated with a 5-point Likert-type scale whose modalities could vary according to the type of item.

EFA

227 participants (M = 24.6 years, SD = 8.51), including 189 women, 34 men and 4 unidentified gender individuals were recruited for this first step. Participants completed the two questionnaires online on the Qualtrics platform (https://www.qualtrics.com, Provo, UT). The different blocks of questions within each scale were presented randomly, as well as the questions within blocks.

Prejudice scale.

The EFA revealed an internal structure of the prejudice scale as having five latent factors. However, six items had to be discarded in the final model in order to obtain a reasonable fit of the data. Once these items were discarded, the scale was composed of four latent factors which can be renamed *'indirect expression of prejudice',* containing five items, *'direct expression of prejudice',* containing six items, *'affect towards North African culture',* also containing six items, and finally *'general affect towards North Africans'* containing 5 items. The details of the analyses are presented in Appendix B. An analysis of the internal consistency using MacDonald's ω presented satisfactory results for all four factors (Table 2.1).

Table 2.1

Factor reliability statistics for the prejudice scale (EFA)

	Cronbach's α	McDonald's ω	Mean	SD
Factor 1: *'indirect expression of prejudice'*	0.79	0.80	1.69	0.68
Factor 2: *'direct expression of prejudice'*	0.83	0.84	2.31	0.74
Factor 3: *'affect towards North African culture'*	0.76	0.77	2.89	0.77
Factor 4: *'general affect towards North Africans'*	0.77	0.79	1.98	0.64

Note. Scale points were in the range of 1 to 5.

Contact scale.

The EFA revealed an internal structure of the contact scale as having four latent factors. Only one item, which had a low loading, had to be disregarded from the final questionnaire. The four factors can be named as follow, '*positive contact',* containing 4 items, *'physical avoidance'* containing six items, *'negative contact'* including 4 items, and finally *'conversation subject avoidance'* gathering three items. The details of the analyses are presented in Appendix B. Here again, an analysis of the internal consistency using the MacDonald's ω presented satisfactory results for all four factors (Table 2.2).

Table 2.2

Factor reliability statistics for the contact scale (EFA)

	Cronbach's α	McDonald's ω	Mean	SD
Factor 1: *'positive contact'*	0.88	0.89	2.88	0.80
Factor 2: *'physical avoidance'*	0.87	0.87	1.95	0.86
Factor 3: *'negative contact'*	0.84	0.84	4.33	0.56
Factor 4: *'conversation subject avoidance'*	0.82	0.82	2.14	1.04

Note. Scale points were in the range of 1 to 5.

CFA.

218 participants ($M = 27.8$, $SD = 13$), including 190 women, 23 men and 4 whose gender was not identified were recruited for this second analysis. The two scales for this analysis corresponded to those constituted by the items selected after the first factor analysis (EFA) explained above. A total of 55 items were presented; the attitude scale comprising 22 items and the contact scale 23 items. Both were imputed on the Qualtrics platform (s,c Provo, UT) with the same randomised within and between block structure used previously.

Prejudice scale.

The CFA did not allow me to re-validate the initial structure put forward with my first analyses. In particular, it was necessary to make post-hoc adjustments. These consisted of moving items from one latent factor to another in order to improve the overall fit of the data to the model. The final structure remains globally acceptable although imperfect.

Table 2.3

Factor reliability statistics for the prejudice scale (CFA)

	Cronbach's α	McDonald's ω	Mean	SD
Factor 1:: *'indirect expression of prejudice'*	0.73	0.76	1.80	0.74
Factor 2: *'direct expression of prejudice'*	0.83	0.83	2.26	0.73
Factor 3: *'positive affect'*	0.80	0.81	2.58	0.64
Factor 4: *'negative affect'*	0.78	0.79	1.78	0.87

Note. Scale points were in the range of 1 to 5.

The final scale was still divided into 4 factors, but the change in the affiliation of certain items, particularly for factors 3 and 4, gave a new meaning to the latter, leading me to change their names. These are *'indirect expression of prejudice'* with four items, the second factor *'direct expression of prejudice'* with 6 items, the third factor *'positive affect'* with 9 items and finally the fourth factor *'negative affect'* with 3 items. The analysis of the internal consistency using the MacDonald's ω presented satisfactory results (Table 2.3) although other indicators of fit measures are not as satisfactory (Appendix B, Table B.5).

Contact scale.

As with the prejudice scale, the model fit indices of the structure previously developed with the EFA did not prove completely satisfactory. However, no changes were made in order to preserve the meaning of the different latent structures put forward. The overall structure is thus acceptable, although not perfect. The same structure in four underlying factors was kept, with the same number of items for each ('*positive contact'*; *'physical avoidance'; 'negative contact': 'conversation subject avoidance')*. The analysis of the internal consistency using the MacDonald's ω presented satisfactory results (Table 2.4).

Table 2.4

Factor reliability statistics for the contact scale (CFA)

	Cronbach's α	McDonald's ω	Mean	SD
Factor 1: *'positive contact'*	0.88	0.89	2.75	0.77
Factor 2: *'physical avoidance'*	0.90	0.90	2.14	0.98
Factor 3: *'negative contact'*	0.85	0.85	4.31	0.63
Factor 4: *'conversation subject avoidance'*	0.83	0.83	2.33	0.99

Note. Scale points were in the range of 1 to 5.

Final scales

Through two analyses reported above, two scales were tested, one for contact and one for prejudices. Both have four factors structures, those structures can be find in Appendix E (Box E.1 and Box E.2, French and English translation). However, the sub- factors are not of any particular interest to validate the hypothese put forward in the main experiment. In particular, the predictions made are based on the impact of prejudice as a single measure, and social contact as a combination of quantity and quality of interactions, and contact avoidance as a combination of physical and conversation avoidance. As a result, I tested the internal consistency of the combined measures with McDonald's ω. The dimension of prejudice consisted of all items from the four factors of the prejudice scale. The dimension of social contact (quality and quantity) grouped the items of factor 1 and 3 of the contact scale (namely 'positive contact' and 'negative contact'). Finally, the dimension of avoidance of contact grouped the items of factor 2 and 4 of the contact scale (namely, 'physical avoidance' and 'conversation subject avoidance'). The analysis of the internal consistency using the MacDonald's ω presented satisfactory results (Table 2.5). The scale in their final form (translated into English) are available in the materials section (Box 2.1 and 2.2).

Table 2.5

Factor reliability pf prejudice, social contact and avoidance for the final scales

	Cronbach's α	McDonald's ω	Mean	SD
Prejudice	0.88	0.88	2.24	0.54
Social contact	0.82	0.83	3.20	0.56
Avoidance	0.88	0.88	2.21	0.87

Note. Scale points were in the range of 1 to 5.

Procedure

Before each test, participants were randomly assigned to experimental groups (threatening, neutral or friendly) and the procedure was adapted accordingly. All participants were informed that the experiment, presented as a study on face perception, lasted approximately 45 minutes. On arrival, participants were led into the CCU (Cognition, Comportement and Usage) laboratory area, into the room equipped for the study. Once the consent form had been filled out and the instructions given, we proceeded with the wiring of the two electrodes on the participant's torso for the recording of the heart rate. One was attached to the right clavicle and the other under the left pectoral muscle. Then the participant sat on a chair, with chinstrap in place, facing the fixed screen. The eye-tracker was calibrated and the actual experiment could then begin. The study procedure was announced to the participant, they were advised that they were going to observe faces of individuals on the screen and potentially interact with them. The participant was asked to pay close attention during the encoding phase, but it was not indicated that it would be necessary to recognize them at a later stage. The participant was also not told how they would come into contact with the individual seen in the photo in order to suggest that the interaction could take place face to face.

Then, it was necessary to record participants in a period of relative physiological relaxation, in order to obtain baseline measures of pupillary dilation and heart rate. An image of a landscape and soft music played through headphones were delivered to the participants for 5 minutes. Since it was also necessary to obtain a comparative baseline for the self-reported anxiety measures, participants had to complete the STAI (form Y-B).

Once the STAI (Y-B) had been completed, 18 faces were presented to the participants, nine from each group (European and North-African) for 1.5 second each. Depending on the "threat" group participants were randomly assigned to before the start of the test, the faces presented were either "threatening" (angry), "neutral" or "friendly" (smiling).

During this encoding phase the participant was asked to enter into social interaction with one of the European and one of the North-African persons (each of which was randomly selected). In reality, the participant was interacting with an accomplice of the experimenter, present in another room. The announcement of the impending social interaction was deliberately made vague, it was not specified under which circumstances the interaction would take place in order to make the participant believe that the individual seen in the photo would potentially physically enter the room for the interaction. After this announcement, the participant was asked to stare at a fixation cross on the screen for one minute in order to measure

his or her state of physiological arousal through pupillary dilation. The participant was then asked to complete the STAI (Y-B) again.

At this point, the participant could get in touch with the individual last seen in the picture, and it was indicated that the interaction would be virtual on an instant messaging for about 5 minutes, that the two individuals could not see each other, and that their conversation topic was to be self-determined. The accomplice chatting with the participant adapted her topic of conversation and her way of interacting according to the stimulus group and the experimental condition. The same process was repeated for both interactions.

After the encoding and contact phase, a short crossword puzzle completion task was delivered to the participant in order to clear the working memory and increase the difficulty of the recognition task.

Once this task was completed, the participant completed the recognition task. The 18 previously encoded faces were presented among 18 new faces (nine European and nine additional North-African). The "YES" or "NO" responses were recorded via an automated response system (AOI trigger).

Finally, the participant was asked to complete the tablet-based questionnaires on social interaction patterns and attitudes toward North-Africans and a set of demographic questions, including self-reported ethnic group. For the latter, two pieces of information were requested, the first being the geographical area of birth of each of the four grandparents and the second a question on phototype, taken from Fitzpatrick's (1975) work on skin reactivity to the sun. Together, these items provide a general idea of the participant's ethnic group. This approach was considered by the ANR team and validated by the Toulouse Ethics committee in order to observe the laws in force on recording ethnicity in France. This technique was used in all experimental protocols used in this PhD.

At the end of the study, the experimenter presented the objectives of the study, revealing to the participant that this experiment was in fact not just about the perception of others, but about differences in recognition and attitudes based on the group the individuals belonged to. The experimenter explained the reason for staging the instant messaging and revealed the presence of an accomplice in another room.

Furthermore, the experimenter made sure to reassure the participant about the difficulties encountered in recognizing faces of North-African origin by presenting the universal aspect of the bias and responded to all of the participant's questions. Finally, the experimenter made sure that the participant agreed to the of use of the data from the experiment,

including his or her origin, despite the fact that part of the objectives had not been provided at the beginning of the experiment.

Since the procedure was quite complex, please refer to the explanatory diagram in Figure 2.1 for clarification.

Figure 2.1

Flow chart of the procedure
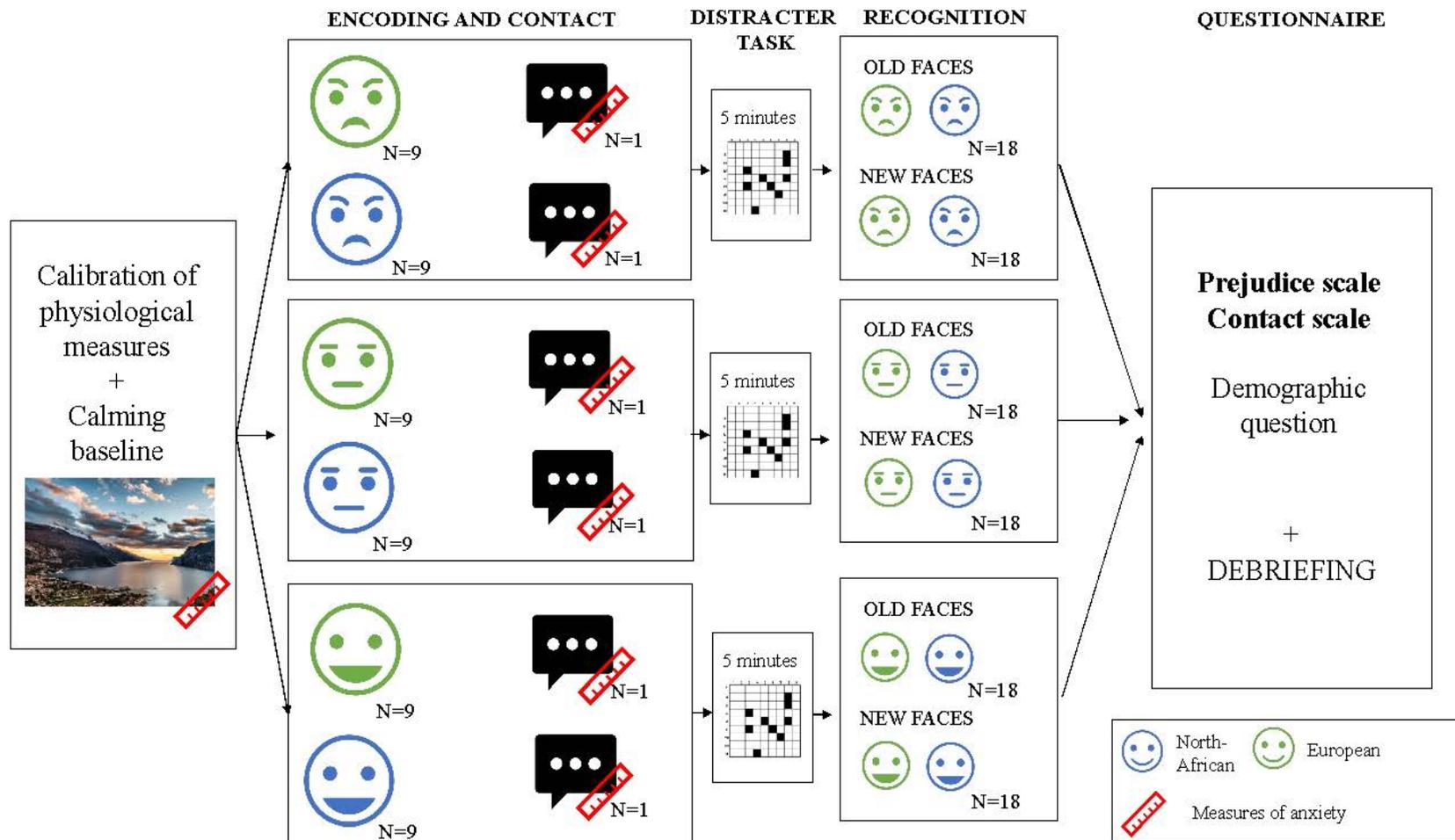
Note. Participants were divided after the baseline into three experimental groups, from top to bottom: Angry/threatning, Neutral and Happy/friendly

Measures

Recognition performance for own and other-group faces was measured with an old-new recognition test (yielding hit rate, false alarm rate, and the signal detection measures *d'* and *c*, Stanislaw & Todorov, 1999).

Eye movements were recorded during the encoding and recognition phases and provided measures of visual strategies for North-African and European faces. Two AOIs (Areas of Interest) were defined on each stimulus face, namely the top area of the face (from hair to midle of the nose) and bottom area of the face (from the middle of the nose to the chin) (Figure 2.2).

The two measures of visual strategies used were the number of fixations per AOI and the total dwell time of an AOI in milliseconds.

Figure 2.2

Illustration of the cut-out of the face stimuli into "Upper-area" and "Lower-area" Areas of Interest (AOI)
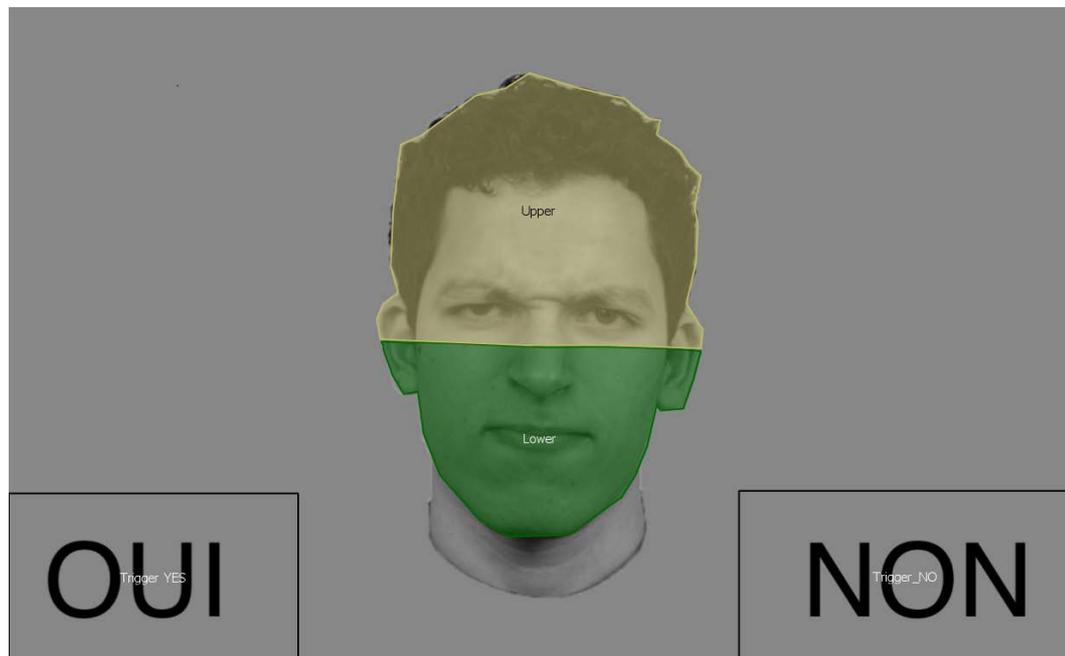
Note. This stimuli correspond to one of the recognition phase. The AOI "Upper" is in yellow, the AOI "Lower is in green. The two additional '*Trigger*' AOI were designed to collect the response "Yes" or "No" during the task of face recognition.

Social anxiety was measured in a self-reported manner and with physiological indices. The STAI-Y is divided into two sub-scales, one for the trait of anxiety (Y-A), to capture what

the participants feels generally, and one for the anxiety state (Y-B), to assess what the subject is feeling in the moment. Only the second form was used in this experiment. The scale is composed of 20 questions to which the participants answers on a four point Likert scale. It yields self-reported social anxiety scores ranging from 20 to 80. The scale is available in Appendix A.

Participant pupillometry and heart rate were also used to obtain an estimate of our participants' arrousal. The self-reported and physiological measures were recorded at key time points (baseline and pre-interaction). Three measures were collected at different times;, those collected before interaction were compared to the baseline in order to determine the variation of social anxiety according to our experimental manipulations.

The dilation of the pupil can be used to some extent to measure the arousal from an external stimulus and can be linked to the change of affect (Mathôt, 2018). Similarly heart rate variability (HRV) can be used to measure the arousal response to a specific stimuli and has previously been used to check induction of an emotion (such as threat) based on a visual stimulus (Choi et al., 2017).

All statistical analyses were conducted using the R statistical programming language (R Core Team, 2021).

Prejudice and patterns of social interaction with North-African individuals were measured using the two scales developed and reported previously. The complete scales are available below.

Box 2.1.

Prejudice Scales

Q1-1: 'I think there may be objective reasons for the reluctance of employers to recruit people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-2: 'I think there is no objective evidence to explain the reluctance of employers to recruit people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-7: 'I believe that there may be objective reasons for a landlord's reluctance to rent his flat to people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-19: 'I think that what should count for the owner of a flat looking for tenants is the financial guarantees of the applicant and not his or her ethnic origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-3: 'I believe that there is significant discrimination in employment against people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-4: 'I think that employment discrimination against people of North African origin is overestimated.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-5: 'I think that people of North African origin face great difficulties in renting housing because of their ethnic origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-6: 'I think that the laws in France are generally sufficient to prevent discrimination when a person of North African origin wants to rent a flat.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-10:'I consider that French society is unfair to people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-11: 'I consider that French society makes a lot of efforts towards people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-12:'I am interested in the Muslim religion.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-13: 'I like to listen to North African music.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-14: 'My values are close to the values of people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-15: 'I think it has been/is/will be very rewarding for me to learn Arabic.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-16: 'I like to make Maghrebi recipes.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-22: 'I appreciate the culture of the Maghreb (the Arabic language, gastronomy, literature, visual art, music, dance, heritage, painting, etc.).'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-1: 'I feel confident around people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-2: 'I enjoy interacting with a person of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-3: 'Interacting with a person of North African origin is enriching.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-4: 'I don't feel comfortable with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-5: 'I don't like meeting new people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-6: 'I feel threatened by people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Box 2.1.

Contact Scale

<u>Q4-1</u>: 'How many of your friends are of North African origin?'
None - Some of them - Half of them - Most of them - All

<u>Q4-6</u>: 'In what proportion do you have friendly experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

<u>Q4-8</u>: 'In what proportion do you have enriching experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

<u>Q4-9</u>:'In what proportion do you have positive social interactions with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

<u>Q4-11</u>: 'In what proportion do you feel welcomed by people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

<u>Q4-12</u>: 'I know many people of North African origin'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q4-13</u>: 'I frequently interact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q4-14</u>: 'I live or have lived in an area where I interact/interacted with many people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q4-15</u>: 'I interact daily with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q4-16</u>: 'In general, I only interact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q3-1</u>: 'When I drive in the city, I prefer to avoid neighbourhoods where there is a strong presence of people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q3-2</u>: 'Sometimes I make a diversion to avoid contact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q3-3</u>: 'In general, I try to avoid neighbourhoods where there is a strong presence of people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

<u>Q3-4</u>:'When I chose my accommodation (flat, room, house, etc.), I avoided areas with a strong North African presence.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-5: 'When I walk in the city, I prefer to pass through areas where there is a strong presence of people from the same ethnic group as mine.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-6: 'When I choose a restaurant, bar or club, I avoid places where there is a strong presence of people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q4-4: 'To what extent do you feel devalued by people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-5: 'How often do you have unpleasant experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-7: 'In what proportion do you have negative social interactions with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-10: 'In what proportion do you feel insulted by people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q3-7: 'In general, when I talk to a person of North African origin, I prefer to avoid talking about international conflicts.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-8: 'De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de terrorisme.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-9: 'Generally speaking, when I discuss with a person of North African origin, I prefer to avoid certain subjects such as secularism or religion.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Results

Anxiety manipulation check

First, the effectiveness of the anxiety[9] level manipulation was tested across the experimental groups (threatening, neutral and friendly), the stimulus group (North-African versus European) and the different time of measurement (baseline, before interaction 1 and interaction 2). To do this, I performed a mixed linear model on the three anxiety measures separately (self-report, ECG and pupillometry) with the time of measure, the ethnicity of the interactants and the experimental condition as fixed effects along with participant identity as a random effect. To do this, I used the packages lme4 (Bates et al., 2015), emmeans (Russell et al., 2022), DHARMa (Hartig, 2020), and Car (Fox & Weisberg, 2019) in the R language.

Self-reported measure (STAI)

I found a main effect of the order of measurement on the STAI scores $\chi^2(2) = 19.17$*, p* $< .001$). However, there were no significant differences between the anxiety conditions or the groups of stimuli on self-reported anxiety.

Post-hoc analyses showed that the level of self-reported anxiety differed between the baseline measure and the measure taken before the first interaction ($M_{Base} = 41.76$, $SD_{Base} = 3.73$ vs. $M_{T1} = 43.23$, $SD_{T1} = 4.63$, $p < .001$, $t = -4.35$, $d = 0.68$) and between the measure taken before the first interaction and the second interaction, respectively ($M_{T1} = 43.23$, $SD_{T1} = 4.63$ vs. $M_{T2} = 42.16$, $SD_{T2} = 4.21$, $p = .01$, $t = 3.10$, $d = 0.48$).

However, no significant difference was found between the baseline measure and the second interaction. The first interaction generated enough anxiety to create a significant difference with the baseline, but the anxiety decreased to a level similar to the baseline before the second interaction.

Measure of pupillometry

I found among other main effects and two-way interactions, a three way interaction between time of measure, experimental condition and the ethnicity of the stimuli on pupil dilation ($\chi^2(4) = 131.11$*, p* $< .001$). Figure 2.3 shows a clear difference between the measurement times, and in particular between time 0, which corresponds to the baseline, and times 1 and 2 respectively, which correspond to the periods before interaction.

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[9] Please note that I refer to the generic term of anxiety and anxiety level when referring to my 3 measures. However, regarding the physiological measure, one could refer to "arousal" and variation in arousal, the anxiety being an interpretation of such physiological change. This element will be discussed later on.

Figure 2.3

Pupillometric dilation as a function of time measurement, anxiety condition and ethnicity order
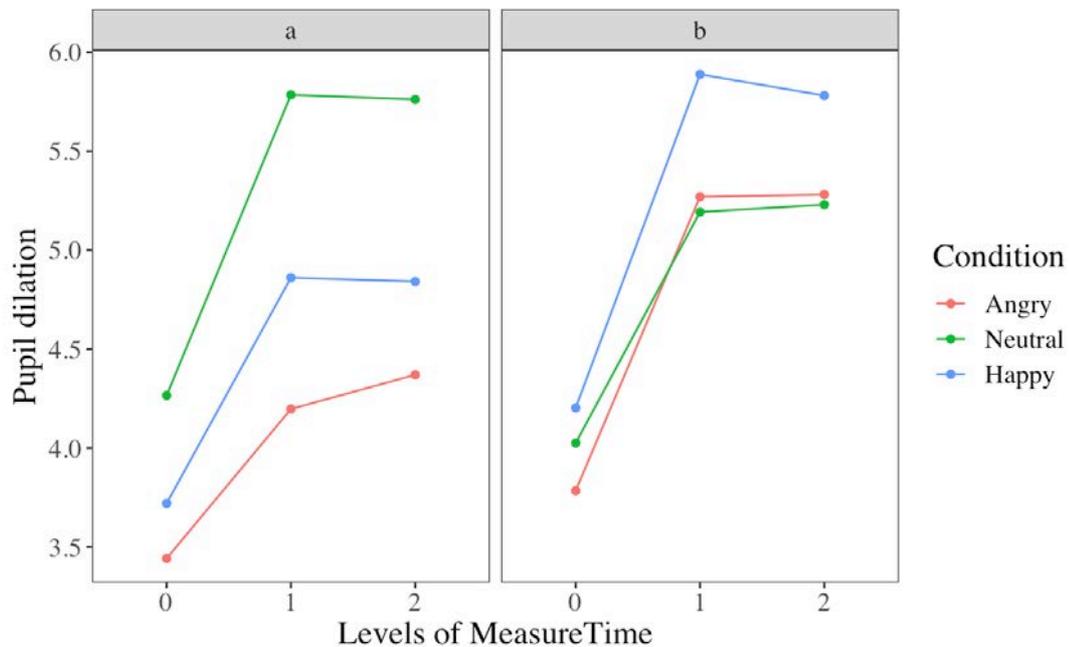
Note. Figure (a) corresponds to a presentation of a North-African individuals for the first interaction and an European for the second interaction. Conversely, Figure (b) corresponds to the presentation of an European for the first interaction and a North-African for the second.

The time of measure 0 corresponds to the baseline, time 1 and 2 correspond respectively to the measure before the first interaction and the second interaction.

Further post-hoc analysis showed that across all experimental conditions and whether it was a North-African which the participant discussed with first, or a European, both interactions activated an increase in pupil dilation. However, the level of anxiety (pupil dilation) between the two interactions did not differ significantly (Figure 2.3).

Surprisingly, the experimental condition with the "angry" faces was not the most anxiety provoking. And this was found for both orders of presentation of ethnicity of stimulus (North-African or European first). The "neutral" and "happy" stimulus conditions were more anxiety-provoking for the participants than the 'angry' stimulus condition. It would therefore appear that the manipulation of anxiety into three increasing levels from "happy" to "angry" to "neutral" did not work as intended.

Finally, the results regarding the impact of the interlocutor's ethnic group was more difficult to interpret. From inspection of Figure 2.3 it appears clear that whatever stimulus group

was presented first both interactions generated the same amount of anxiety. However, the condition where a European interlocutor was presented first generated more anxiety in general (for interaction 1 and 2) than when the North-African individual was presented first. These results therefore do not fully support the hypothesis that interaction with North-African individuals always generate the most interaction anxiety in participants.

Measure of heart rate variability (ECG)

The HRV indicators were modelled in the same way as pupillometric and self reported measures but no main or interaction effect were detected. Participants' heart variability measurements did not differ according to the time of the experiment (interaction or not), the condition ("angry", "happy", "neutral") or whether the interlocutor was North-African or European.

Correlation between anxiety measures

A correlation matrix between the self-reported measure, the pupillometric measure and the cardiac indicators showed significant correlations between each of the cardiac indicators but only a weak significant correlation between the self-report measure and the pupillometric measure ($r = 0.14$, $p < .001$). Regarding those correlation and the absence of significant effects present with the cardiac measures, the three ECG indicators were dropped in further analyses.

Social contact and prejudice

Responses to questionnaires on social interaction patterns and prejudice towards individuals of North-African origin were grouped by the three dimensions of interest, namely social contact (quantity and quality), avoidance of interaction and prejudice, with the structure of items presented in the Box 2.1 and 2.2. Prejudice was scored so that the higher the score, the higher the level of prejudice. Social contact was scored so that the higher the score, the more positive quality and quantity of contact it reflects. Items on negative contact were reversed to achieve this. Finally, scores for contact avoidance were so that the higher the score, the higher the avoidance behaviour. Correlations between these three elements are significant and present results that confirm my hypotheses (Table 2.6).

In particular, contact avoidance is strongly positively correlated with prejudice and negatively correlated with the quantity and quality of contact. Conversely, social interaction patterns are strongly negatively correlated with prejudice, replicating results from the literature on contact theory.

Table 2.6

Means, standard deviations, and correlations with confidence intervals

Variable	*M*	*SD*	1	2
1. Prejudice	46.26	9.43		
2. Self-reported contact	42.64	6.86	-.55** [-.68, -.38]	
3. Contact avoidance	18.33	6.42	.57** [.41, .70]	-.45** [-.60, -.26]

Note. Values in square brackets indicate the 95% confidence interval for each correlation.

*: $p < .05$; **: $p < .01$.

Modelling of face recognition performance

Modelling the recognition data proved to be complex as a large number of variables and interactions between them had to be tested. To do this, I proceeded in several steps. First, I selected only the pupillometry measure as the anxiety measure.

Then, I modelled the data in several stages, starting with a relatively simple model of the variables manipulated in the experimental design. For each model I applied the same logic for both measures of the Signal Detection Theory, namely the measure of discrimination (*d'*) and response criterion (*c*).

I modelled the recognition data with the experimentally manipulated variables using a generalized mixed linear model, with the manipulation of contact[10] (live interaction), ethnicity of target faces (stimulus group) and experimental condition (angry, neutral and happy) as fixed effects and participant identity as a random effect. I found a main effect of the stimulus group on *d'* (χ^2 (1) = 5.82, *p* < .03). Participants showed better discrimination of European faces compared to North-African faces (M_{Eur} = 1.70, SD_{Eur} = 1.23 vs M_{NA}= 1.41, SD_{NA} = 1.19, *p* < .03, *t*= 2.48, *d* = 0.24) (Figure 2.4). However, no effect of the experimental or manipulated contact was evident on recognition.

Applying the same logic, I modelled the criterion of response (*c*) using a generalized mixed linear model, with the manipulation of contact (live interaction), ethnicity of target faces

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[10] Throughout the description of the results, I will use the term "manipulated contact" to refer to the conditions of possible social interactions during the experiment (encoding with contact or without). Conversely, I will use the term "self-reported contact" (contact_sr) to refer to the contact scores obtained with the questionnaire.

(stimulus group) and experimental condition (angry, neutral and happy) as fixed effects and participant identity as random effect. As for the *d'* I found a main effect of the stimulus group on *c* (χ^2 (1) = 10.30, *p* < .01). Participants presented higher response criterion, so a more conservative type of response (response tendency to the "no") for the European faces than North-African faces (M_{Eur} = 0.18, SD_{Eur} = 0.62 vs M_{NA} = -0.02, SD_{NA} = 0.63, *p* < .01, *z* = 3.28, *d* = 0.32). The liberal response criterion, which was more used for North-African faces (response tendency to the "yes") is classical in the OGRB. It creates more false alarm and therefore worst discrimination performances.

Figure 2.4

Mean of discrimination (d') of European observers for European and North-African stimuli.
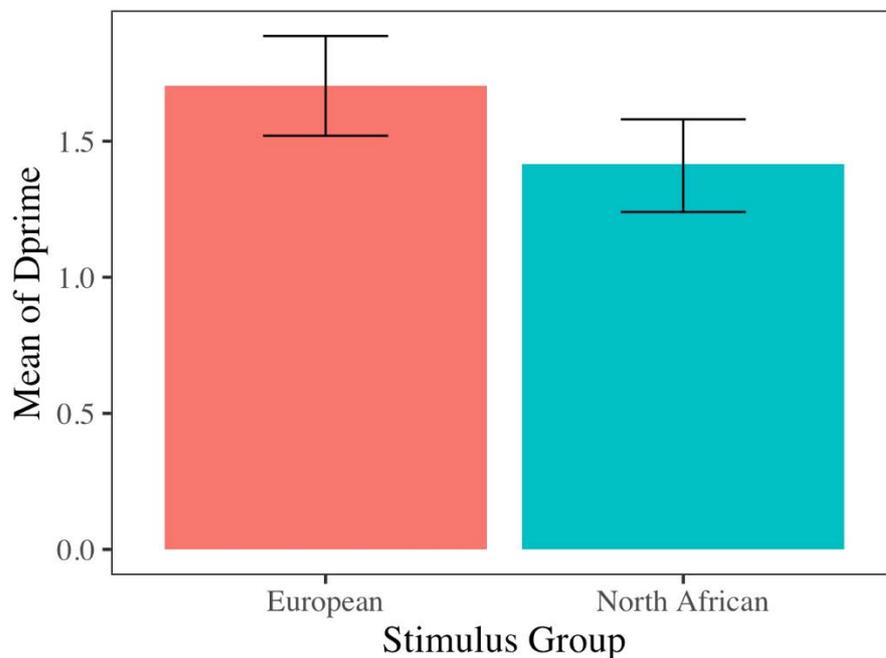
Note. Error bars are 95% bootstrap confidence intervals. European stimulus faces were better recognized from the European participants in comparison to North-African faces stimulus.

In a second analysis, I modelled the data using the same variables, but adding the measures of social contact patterns with North-Africans: quantity/quality of interactions and the avoidance of contact, as fixed effects, keeping participant identity as a random effect. The objective was to test possible differences of effects from the first model when adding the other variables of interest. Results were congruent with the first model, showing a main effect of Group on d' (χ^2 (1) = 5.85, $p < .03$). One can also note, although it did not reach the significance level, a tendency of a two-way interaction between the group and the self-reported contact (Table 2.7). An inspection of the figure of interaction between those variables suggests better recognition of North-African faces when self-reported social contact is high compared to when social interaction is low, and surprisingly, a decrease of face recognition for European stimuli (see Appendix F for the figure, which is not shown here, since the result was not formally significant).

The response criterion model, with the same modelisation as for d', still showed only a main effect of the stimulus group on c (χ^2 (1) = 10.32, $p < .01$).

Table 2.7

Anova results for the second analysis, modelling d' for North-African and European stimuli

	χ^2	Df	p.values
Stimulus Group	5.85	1	.016 *
Contact_manipulation	1.36	1	.243
Condition	3.93	2	.140
Contact_self_reported	0.38	1	.539
Avoidance	0.49	1	.486
Stimulus Group x Contact_manipulation	0.21	1	.644
Stimulus Group x Condition	3.33	2	.189
Contact_manipulation x Condition	2.81	2	.246
Stimulus Group x Contact_self_reported	3.06	1	.080 .
Stimulus Group x Avoidance	1.95	1	.163
Stimulus Group x Contact_manipulation x Condition	2.69	2	.260

Note. **: $p < 0.01$; *: $p < 0.05$; .: $p < 0.1$

In a final model, I included the variables assessed as potentially moderating the effects of the self-reported contact pattern on face recognition, i.e., the level of prejudice. And the variables that could impact the manipulation of contact during the experiment, i.e., interaction anxiety and the level of prejudice. This analysis is thus of the most complex model representing the data from my experiment, and includes the full range of expected interaction effects. As previously demonstrated, only the stimulus group was shown to have a significant effect on d' ($\chi^2(1) = 5.59$, $p < .03$). No other main or interaction effects were significant.

The response criterion model for this third model was still consistent from the first modelisation of data and presented a main effect of the stimulus group only ($\chi^2(1) = 10.15$, $p < .01$).

Visual strategies

Two indicators of visual strategies were measured: the number of fixations (counts), and dwell times (milliseconds). Data were collected on two areas of interest: the upper and lower areas of the stimulus faces. As the exposure times of the stimuli were not similar across encoding (limited time of 1.5 sec) and recognition (unlimited time), the analyses were conducted separately on these.

Number of fixations

Encoding

For the analysis of the number of fixations during encoding, I used a generalized mixed model with the ethnic group of the stimulus, AOI, self-reported contact and avoidance of contact, as fixed effects along with participant as a random effect, and the probability distribution as Poisson. The manipulated contact variable was not included in this analysis since it occurred after encoding. One can observe a main effect of the AOI on the number of fixation during encoding ($\chi^2(1) = 7880.41$, $p < .001$). Across all experimental conditions and stimulus groups the upper region of faces attracted more fixations compared to the lower region ($M_{Upper} = 4.44$, $SD_{Upper} = 2.71$, $M_{Lower} = 1.69$, $SD_{Lower} = 1.61$, $p < .001$, $z = -88.76$, $d = 1.03$).

Recognition

In the analysis of number of fixations during recognition, I kept the same model structure as previously and added the variable of the manipulated contact and the experimental condition of level of anxiety as fixed effects. I observed multiple main effects and interactions, including some that were not expected (Table 2.8).

First, one can note a main effect of the AOI, as stated during the encoding, the top of the face, across all group, gathered the most fixations $(M_{Upper} = 3.58, SD_{Upper} = 3.22 , M_{Lower} = 1.70, SD_{Lower} = 1.74, p < .001, z = -33.23, d = 0.73)$. Then, one can observe that the contact manipulation, also across the different ethnic stimulus groups, impacted significantly the number of fixations, although the effect size is small. Stimuli encoded with social interaction gathered fewer fixations during the recognition phase in comparison to stimuli encoded without social interaction $(M_{NoCont} = 2.67, SD_{NoCont} = 2.79 , M_{Cont} = 2.39, SD_{Cont} = 2.36, p < .05, t = 2.11, d = 0.10)$.

Table 2.8

Anova results of the model of number of fixations during recognition of European and North-African faces

	χ^2	Df	p.value
AOI	2960.35	1	< 2.2.^{e}-16 ***
Stimulus_Group	0.02	1	.882
Contact_sr	2.39	1	.123
Avoidance	1.54	1	.215
Contact_manipulation	10756.80	1	< 2.2.^{e}-16 ***
Condition	1.08	2	.584
AOI x Stimulus_Group	0.01	1	.917
AOI x Contact_sr	35.82	1	< 2.17.^{e}-09 ***
Stimulus_Group x Contact_sr	4.13	1	.042 *
AOI x Avoidance	102.63	1	< 2.2.^{e}-16 ***
Stimulus_Group x Avoidance	0.04	1	.048
AOI x Contact_manipulation	0.001	1	.040
Stimulus_Group x Contact_manipulation	2.56	1	.031
AOI x Condition	21.20	2	< 2.50.^{e}-05 ***
Stimulus_Group x Condition	6.09	2	.0477 *
Contact_manipulation x Condition	6.41	2	.040 *
AOI x Stimulus_Group x Contact_sr	1.05	1	.306
AOI x Stimulus_Group x Avoidance	0.91	1	.341
AOI x Stimulus_Group x Contact_manipulation	1.88	1	.170
AOI x Stimulus_Group x Condition	2.77	2	.251
AOI x Contact_manipulation x Condition	6.23	2	.044 *
Stimulus_Group x Contact_manipulation x Condition	1.85	2	.397
AOI x Stimulus_Group x Contact_manipulation x Condition	9.39	2	.009 **

Note. Signification codes : '***' 0.0001 '**' 0.01 '*' 0.05 '.' 0.1

Then, I observed multiple two-way interactions that I did not make any apriori predictions on. I did inspect those interactions but do not show them here; all Figures and Tables are available in the Appendices.

First, I noted a two-way interaction of the AOI and the self-reported measure of social contact on the number of fixations. As the latter variable is continuous, I factorised it using Aiken and West's (1991) methodology. With visual inspection (Appendix G), it appears that the self-reported pattern of contact impacted the number of fixations, specifically on the upper area of the face. Further contrasts in post-hoc analysis confirmed that individuals with high levels of interaction with North-Africans fixated more on the upper area of faces compared to individuals with low levels of interaction $(M_{HighC} = 4.68, SD_{HighC} = 2.91, M_{Low C} = 3.92, SD_{LowC} = 2.26, p < .05, z = 2.87, d = 0.51)$.

The next interaction effect between the group and self-reported contact on the number of fixations showed that high and low levels of self reported interaction were associated with higher numbers of fixation on North-African individuals compared to Europeans. However, this difference was not significant for participants presenting medium levels of social contact with North-African individuals (Appendix H).

Another two-way interaction between the AOI and avoidance is evident. Here again, as avoidance is a continuous variable, a factorisation was necessary. Visual inspection of the relation showed that avoidance seemed to decrease the number of fixations on lower-parts of the face (Appendix I). However, further contrast analysis revealed no significant differences.

Because I have demonstrated a four-way interaction between AOI, group, contact manipulation and the experimental anxiety condition, I will not describe the two-way and three-way interactions where these variables were involved together. Figure 2.5 shows an illustration of this four-way interaction.

Figure 2.5

Measure of number of fixations as a function of AOI, Stimulus Group, Condition and Manipulated Contact during the recognition phase.
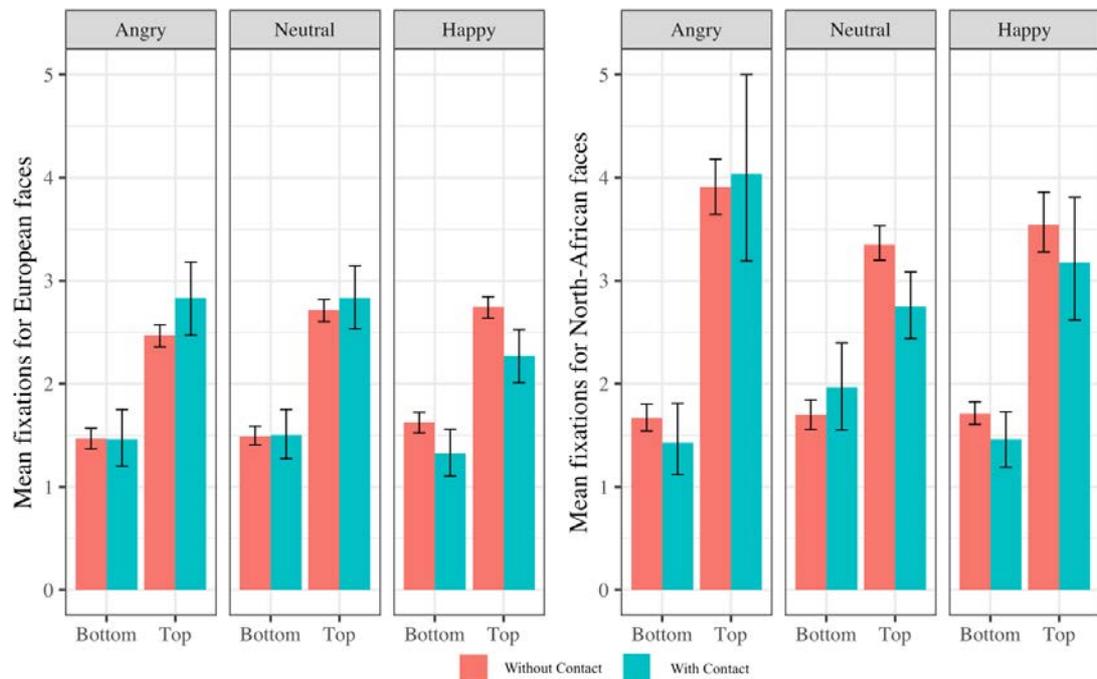
Note. Error bars are the 95% bootstrap confidence intervals

By visual inspection of Figure 2.5, similar patterns of fixation frequency are found for the European and North-African stimuli. For each experimental condition (angry, neutral and happy), the number of fixations is greater on the upper than on the lower part of the face. However, whereas for Europeans there seems to be little difference in the number of fixations between conditions, there might be larger differences for North-Africans. For example, in the neutral condition, the European faces do not seem to have benefited from any visual processing differentiated according to whether or not contact took place during encoding. Conversely, for North-African faces, a greater concentration on the top of the face can be observed for stimuli encoded without contact. In the 'Angry' and 'Happy' conditions, it seems that North-African faces benefited from a greater focus on the upper part of the face compared to the other conditions and to European faces.

Dwell times

Encoding

In the same manner as for the number of fixations, I modelled dwell time data at the encoding stage with AOI, Stimulus Group and Manipulated Contact as fixed effects along with

participant as random effect. I observed a main effect of the AOI on dwell times ($\chi^2(1) = 580.19$, $p < .001$). As with the number of fixations, dwell times are higher on the upper area than on the lower area of faces across all groups and conditions ($M_{Upper} = 1620.42$, $SD_{Upper} = 500.73$, $M_{Lower} = 522.83$, $SD_{Lower} = 456.34$, $p < .001$, $t = 24.09$, $d = 2.37$).

Recognition

In the analysis of number of fixations during recognition, I kept the same model structure as previously and added the variable Manipulated Contact and the experimental condition of level of anxiety as fixed effects. I observed here again a main effect of the AOI on dwell times ($\chi^2(1) = 222.01$, $p < .001$). As for encoding, the upper area of all faces gathered longer times of fixation than the lower parts of stimulus faces ($M_{Upper} = 1047.45$, $SD_{Upper} = 1098.32$, $M_{Lower} = 472.16$, $SD_{Lower} = 502.65$, $p < .001$, $t = 14.93$, $d = 0.93$). I observed a second main effect, although small, of the contact manipulation on the dwell times ($\chi^2(1) = 22.44$, $p < .001$). Stimulus faces encoded without social interaction gathered longer fixation times during recognition than stimuli faces encoded with social interaction ($M_{NoCont} = 767.23$, $SD_{NoCont} = 920.53$, $M_{Cont} = 700.89$, $SD_{Cont} = 727.58$, $p < .001$, $t = 4.83$, $d = 0.10$). No other effects, main or interaction, on fixation times were found.

Discussion

The aim of this study was to observe the impact of a range of cognitive and social factors on face recognition performance and strategies of face scanning. Some of the hypotheses put forward could be corroborated, but a number of them could not be.

First, the manipulation of interaction anxiety, tested with three measures, was not fully successful. The self-reported measure (STAI) informed us that interaction anxiety was indeed induced, but only for the first interaction, and no clear differences occurred between groups of stimuli (North-African versus European) or anxiety conditions. The pupillometric measure informed us that the participant's arousal increased between baseline and before each of the interactions, suggesting that the interactions were indeed anxiety-provoking for the participants. Furthermore, the anxiety condition also appeared to induce different levels of physiological reaction, but in a relatively unexpected way. Indeed, the "neutral" and "friendly/happy" conditions increased participants' arousal more than the "threatening/angry" condition. The measurement of heart rate variability, on the other hand, did not show any differences between the different measurement times, anxiety conditions, or groups of stimuli. For these reasons, this measure was not retained in the further analyses.

Therefore, this manipulation check is not conclusive. Social interaction with an unknown person was anxiogenic but the hypothesis that it would be more anxiety-provoking depending on the ethnic group of the interlocutor has not been verified. Manipulating emotional facial expressions coupled with a specific interlocutor attitude to induce different levels of anxiety also did not work. In fact, when a difference was found between conditions, it appears to be in an opposite direction of what was expected, with the "happy/friendly" condition generating more anxiety than the other conditions.

On measures of prejudice and social contact pattern, there are correlations between these factors that corroborate the literature. Social contact (quantity and quality) is negatively correlated with the level of prejudice as expected. With regard to the addition of contact avoidance, which is one of the experimental novelties for this study, one can also note significant negative correlation with social contact patterns and a storng positive correlation with prejudice. These results therefore confirm the assumptions made about these measures.

With regard to face recognition performance, the data was modelled in three different ways in order to best account for this complex data. Ethnic group was shown to have an impact on recognition performances, with better recognition abilities for European faces (own group) compared to North-African faces (other group). This effect therefore confirms the existence of an OGRB on a European population regarding North-African individuals (H1). There is also a potential trend in the effect of self-reported contact on recognition abilities, particularly for North-African faces. High levels of self-reported contact with this population may be associated with better recognition performance for individuals of this group (H2). However, this effect did not reach significance and caution should be exercised in its interpretation. No other effects could be found. The hypotheses concerning contact, whether manipulated or reported, and the potential interactions with prejudice and interaction anxiety could therefore not be confirmed (H3, H4, H5, H6, and H7).

Finally, with regard to visual strategies, the analysis of the number and dwell time of fixations indicates that the upper face attracts most of the visual attention during both encoding and recognition. And this was true for both European and North-African faces, failing to support the hypothesis of a difference of visual strategies as a function of group (H8). In addition, the manipulation of the contact appears to have impacted both indicators of visual strategies during recognition. Stimuli encoded with social contact benefited from less visual focus during recognition, with notably fewer and shorter fixation than stimuli encoded without contact. Those results partially support the hypothesis of an impact of social contact on visual strategies, although it was present for all stimulus group faces (H10).

Other effects include the impact of the social variables of self-reported contact and interaction avoidance on the number of fixations. However, these effects were not found in interaction with ethnic group of stimuli. It is therefore necessary to be cautious about the interpretation of these effects. In particular, high self-reported contact patterns were found to increase the number of fixations on the upper face (H9). Conversely, high avoidance behaviours appear to decrease visual focus on the lower face (H9). Finally, a four-way interaction between AOI, stimulus ethnic group, contact manipulation and experimental condition could be demonstrated (H11). However, its interpretation remains delicate and cannot confirm the hypothesis according to which the manipulation of the contact would significantly impact the number of fixations as a function of the anxiety conditions. It can be noted, however, that the manipulation of the contact in interaction with the experimental anxiety conditions seems to have had a greater impact on the visual scanning of North-African faces than on European ones.

These results on visual strategies do not allow me to clearly confirm my hypotheses that ethnic group and patterns of social contact and avoidance would significantly impact the number and duration of eye fixations. However, some interesting leads, especially concerning the effects of contact manipulation, seem to emerge.

The results of this study therefore tell us a number of things. First of all, I confirmed the existence of an OGRB concerning European individuals viewing North-African faces, although the effect size was small. I also confirmed that contact interactions induced anxiety, but this seemed to be equivalent across ethnic groups interacted with. Then the measure of prejudice and contact pattern (i.e., quantity, quality and avoidance) were shown to have the expected relationship that has been demonstrated in the litterature. Unfortunately, I did not find evidence supporting the hypotheses concerning the impact of social factors such as the impact of direct interaction, contact patterns, prejudice and inter-group interaction anxiety on face recognition performance. Finally, the results concerning the way social interaction could impact visual strategies are very promising but no clear conclusion can be drawn nonetheless.

There are several possible reasons for the failure to corroborate some of my hypotheses. A first explanation is that I had too little statistical power for some hypothesis tests. The number of participants was chosen in order to satisfy *a priori* power sensitivity calculations, but also by taking into account the constraints of the experimental sessions (long and complex sessions, the need to have an accomplice available, among other factors). Moreover, I underestimated the data loss for this experiment. Two methodological constraints in particular resulted in a significant loss of data, the first being the malfunctioning or difficulty in calibrating the eye-tracker. The latter was essential for the recognition task since the participant selected his or her

response visually by focusing on the "yes" or "no" displayed on the screen. Therefore, when a malfunction of the device occurred it was not possible to proceed with the recognition task. Secondly, internet connection difficulties sometimes made it difficult to complete data from self-reported questionnaires conducted on Qualtrics, thus requiring an internet connection. It is also important to note that this data collection was conducted between February and March 2020 and had to be discontinued due to the Covid-19 pandemic. It was subsequently not possible, for various health and logistical reasons, to resume data collection in 2021.

Besides, one could rethink this study and design it to consist of several simpler investigations. Indeed, the disadvantage of focusing on a single inquiry and integrating a large number of variables as done in this study is that the demand for statistical power is consequently very high. The advantage of using several different, smaller investigations could be to limit the demand on statistical power. However, it is important to be careful in balancing statistical power without oversimplifying the protocol and studying isolated variables detached from the overall context.

With regard to the manipulation of interaction anxiety, several limitations can be underlined. Although the interactions appeared to generate anxiety, the manipulation of the emotional expressions and attitude of the confederate during the interactions was not sufficient to manipulate interaction anxiety as originally intended. In this protocol, much thought was given to how to induce interaction anxiety that was authentic, sufficiently variable and meaningful between conditions, while respecting a minimum of comfort and bearing in mind ethical considerations for the participants. Prior to each interaction, the participant was informed that they could talk to the last person in the picture, but no additional information was provided. Therefore, the participant did not know whether the interaction would take place face-to-face, on-screen or via another medium. As online discussions can be anonymous, this promotes a reduction in interaction anxiety. This was therefore used to place the participant in ecological conditions of social contact and thus measure genuine anxiety about interacting with a stranger that would not have been affected by knowing at the outset that this interaction would not actually take place face-to-face. This short moment of uncertainty before the interaction was the point at which the interaction anxiety measures were recorded. This strategy was designed because I believed that if the participant knew the medium through which the interaction would take place (anonymously on an instant messaging service), the anxiety associated with the interaction would potentially be low or non-existent. However, this strategy had some drawbacks. Anxiety was necessarily higher before the first interaction, where the participant was still naïve to the communication medium, than for the second interaction where

the participant could anticipate the context of the interaction. Furthermore, it is possible to question whether the anxiety generated before this first interaction in particular would not be artificially inflated by the uncertainty in which the participant is immersed, and the lack of information rather than by the interaction itself.

Regarding the surprising finding of higher interaction anxiety in the "happy/friendly" condition than in the other two conditions, is possible that the faces in the "anger/threat"condition were seen as less believable. The frozen expression of anger may have been perceived as unnatural and potentially laughable.

Apart from this the difficulty in relying on correctly manipulating interaction anxiety, one can also question the measures chosen. I chose to select physiological and self-reported measures in order to obtain as complete an account as possible of what the participant experienced during the experiment. Although the aim was to observe physiological and self-reported differences that were large enough to be meaningful across measurement times, groups and conditions, it is not surprising that some measures did not allow me to achieve this objective. Indeed, it is quite possible that the measurement of heart rate variability is not fully adapted to this type of protocol and that the type of anxiety generated by an interaction is not sufficient to elicit a significant cardiac response. Besides, the physiological indicators measure arousal, a physiological activation corresponding to an emotion, which has been interpreted in this context as an anxiety state. It is possible that this interpretation is not entirely accurate, which could explain the difference obtained with a self-reported measure of interaction anxiety.

A major focus of this experiment was to investigate the impact of contact on face recognition but also on the visual strategies used. Two elements were taken into account, the frequency and quality of social interaction with North-Africans, and the introduction of direct contact during the experiment with one member of each group (own- versus other-group).

Regarding self-reported contact, I was unable to replicate the results of the work on the effects of social contact in face recognition. High quality and quantity of contact did not predict better face recognition of the other group. In the same manner, avoidance of interaction was not shown to impact face recognition. This could have to do with the experimental population: indeed, when I examined the distribution of contact scores (quality, quantity and avoidance), it appeared that it is relatively homogeneous and concentrated on a relatively high base. Thus, the population of this experiment, composed of psychology students, turned out to have relatively similar contact histories with North-African individuals. This low variability makes it difficult to show a clear and significant relationship between contact habits and recognition performance. The problem of accessing representative samples of the population is not new in

experimental psychology but makes it more difficult of course to draw generalizable conclusions.

Another part of the answer may lie in the period of the assessment of contact patterns. Indeed, recent work suggests that the study of contact as currently conducted in the literature ignores the existence of a critical period during which contact is important in the acquisition of recognition expertise and beyond which the effects of contact are negligible (McKone et al., 2019). In our study, the questionnaire on social interaction patterns did not specify a particular period and generally covered all past interactions. It is conceivable that the responses given by participants reflect more immediate experiences than the contact experiences included in the time period suggested by McKone et al., which would end at around 12 years.

It can be noted, however, that the different contact indicators used in my study (quantity, quality and avoidance) correlate well and as expected with each other and also with the prejudice variable, indicating that their simultaneous study could, in a different context, be quite appropriate and interesting to bring light to the puzzle of understanding the OGRB.

Regarding the impact of the manipulation of live contact on face recognition performance and its modulation of visual strategies, encouraging effects have been shown, especially concerning its impact on visual strategies. A first social contact, even a short one, can impact the visual scan. In particular, I have shown that faces encoded with contact had a more restricted visual focus than those encoded without contact. This could reflect a lower information processing requirement for these faces (Hooge & Erkelens, 1998) and potentially a more efficient and therefore shorter scanning. The participant requires less time and number of fixations to encode a face that has been associated with a social interaction.

Unfortunately, it was not possible to relate these changes in visual strategies as a function of contact manipulation to better performance in recognising the faces involved. Although it can be noted that participants appeared to believe in these interactions, and a majority reported after the experiment that they thought the two people they interacted with were different and real. Given the literature and the emphasis on the need of repeated contact, the hypothesis that 5 minutes of interaction would have an effect on face recognition performance might have been too ambitious. However, the first results obtained on visual strategies seem encouraging for further research in this direction and confirms previous work with similar experimental protocols (Brunet et al., 2022).

Concerning the absence of evidence for distinctive visual scanning as a function of group, previous studies have presented clearer results on the differences of strategies (see

Stelter et al., 2022, for a review) but it is important to note, that, to my knowledge, none have examined differences between European and North-Africans stimuli. Considering Stelter et al's (2022) proposal about the existence of distal and proximal faces, it is possible that North-African faces are more likely to be considered by European observers to be more proximal than, for example, African or Asian faces, on which the various eye-tracking studies have focused so far.

Finally, the visual strategy measures chosen for this experiment might have also affected the results. Eye-tracking devices are very practical and a reliable tool to explore visual scanning, but, multiple types of measure exist, which makes it difficult to ensure that one uses the most accurate measurement for the test of a particular hypothesis. In the case of this experiment, the already existing complexity of the protocol and the statistical models used led me to favour relatively common and easily modelled indicators. However, there are more complex indicators that could have allowed a finer reading of the visual strategies used. For example, the use of the order of fixations or trajectory scans could have highlighted patterns not evident from the number and dwell time of fixations. Furthermore, the multiplicity of methods used in eye-tracker studies has been repeatedly pointed out as making it difficult to aggregate and summarise the results (Arizpe et al., 2016). In these circumstances, it is not prudent to jump to conclusions about the lack of impact of ethnic group or social contact on visual strategies.

Although this study did not corroborate all of my hypotheses, it provides new insights into the study of cross-group face recognition. An OGRB was demonstrated with a rarely studied stimulus population, North-African individuals. Given the French migratory context and the sometimes tense relations between 'White' French and North-Africans, the evidence of this bias is important. This study has also brought new elements to the study of visual strategies during face encoding and recognition. According to this experiment, there do not seem to be significant differences in the strategies used by European individuals when faced with a European or North-African face. However, this information needs to be confirmed and tested in other experiments and by considering the use of other measures of visual strategies. Furthermore, the results regarding the social variables in the OGRB study may seem slight regarding face recognition performances but interesting elements emerge from the study of visual strategies. In this study, although social interaction patterns did not appear to significantly impact visual strategies, the manipulation of a live social contact did significantly impact visual patterns of fixation number and duration. It seems important to stress that, with hindsight, this type of protocol and the consideration of the different factors mentioned remain

ambitious and imply important methodological and statistical constraints. But that is not to deny that this type of complex protocol deserves to be used.

Part II - The OGRB and within-group variability

Chapter 3 – Systematic Review on phenotypicality bias

In the first part of my thesis, I mainly focused on the social and cognitive factors that could explain the Own-Group Recognition Bias. In particular, I investigated the role of social interaction patterns, both in terms of interaction history and live contact manipulation during an experiment on own-group and other-group face recognition abilities. I added a dimension of interaction avoidance to the study of social contact patterns, which might be particularly important from the perspective of an ecological study of the effects of contact on face recognition.

I then added to these components of social contact, a prejudice variable, repeatedly presented in the literature as central in models of intergroup contact, and an interaction anxiety variable that might be particularly important in explaining intergroup contact avoidance processes. Finally, I investigated, in an exploratory manner, how visual scanning processes could explain the impact of these components on intergroup face recognition.

This line of work showed promising results, although it did not confirm all the experimental hypotheses that had been established. It would have been possible to continue the work in this direction and to develop further procedures on the study of contact and all its related components on the OGRB. However, another aspect of the OGRB has been addressed in the second part of this thesis. For this section, I did investigate the notion of within-group variability and in particular how it may impact on cross-group face recognition.

This different angle on an aspect of the OGRB was done for several reasons. Firstly, the realisation of this thesis project took place partly during the COVID-19 pandemic crisis. The possibility of setting up face-to-face experiments in particular was therefore compromised. As a result, it was not possible to pursue work on visual strategies or manipulating live social contact during a procedure. But most importantly, the concept of perceived within-group variability quickly became a central notion in my study of the OGRB and seemed quite important to consider in my thesis work. Indeed, this notion refers directly to the conceptualisation that one may have of what constitutes an ethnic group. Whether in the populations and stimuli studied, the choice of photographic material, the construction of scales of prejudice and contact patterns, or the exploration of visual scans used when encoding a face, the notion of ethnic group and what it represents in different ways proved to be paramount. Moreover, the conceptualisation of the ethnic group and its within-group variability in regards to the OGRB study is all the more important to take into account as there is little work on the

subject. For these reasons, I focused in this second part of my thesis a focus on this notion of variability. In the first chapter in this section, I established how social psychologists have investigated the notion of perceived within-group variability through a systematic review. Then in a second chapter, I conducted a procedure to consider this component into the OGRB study.

The concept of the ethnic/racial group

Research on the OGRB is based on distinguishing individuals into groups perceived as different 'races' or ethnic groups. It is therefore important to understand what is meant by these concepts. According to Glasgow et al. (2019), there is no consensus in the literature on the definition of 'race'. While it could be, for some, based on a sharing of the same physical characteristics and/or common ancestry linked by a defined geographical space, it could also be based on a much more social notion with a vague and shifting framework. Indeed, if one considers, for example, Malians and Congolese, they might appear to the European eye as a single homogeneous category grouped under the term 'African'. Conversely, to a Congolese person, Malians might be seen as a completely different ethnic category to themselves. It is possible to define two main definitions of 'race', one based on a presumed biological reality (a belief founded in essentialism) and the other based on a social construction.

The basis of 'race' as a defined biological entity is particularly problematic, for obvious historical reasons, but also because it is not supported by genetic studies. Several genetic studies have shown that a genome-based conception of ethnic group is incorrect. For example, Rosenberg et al. (2002) have shown that the percentage of genetic variability within one of these racial categories constitutes 93 to 95% of the genomic variability, whereas the differences between these groups are only 3 to 5%. This means that the classification into racial groups ignores a reality of variability in phenotype (i.e., in genome expression).

This notion of biological 'race' has also been strongly criticised and questioned in social science (e.g., Hirschfeld, 1996; Smedley & Smedley, 2005; Templeton, 1998). In this literature 'race' and 'ethnic group' appears to be treated as a social construction, a classification based on a spatial, cultural and temporal context. Racial categorisation has shown to be shifting and flexible (Goodman, 2000). For example, an Italian immigrant at one time in the US was not considered as 'White' as an Irish person.

Categorisation into racial groups is therefore dependent on subjective perception. In order to categorise people into different racial groups, the human brain is likely to use readily accessible cues, especially physical characteristics. Central to the notion of racial categorisation

is the idea of differences in physical appearance between individuals (Sen & Wasow, 2016). Those morphological differences have occasionally been highlighted in anthropological and medical studies (Hajnis et al., 1994; Jablonski & Chaplin, 2000; Le et al., 2002). The categorization of people along 'race' lines develops early in life (Hierschfeld, 1996) and appears to be a rapid, automatic and integrated process (Cunningham et al., 2004; Ito & Urland, 2003), especially as applied to individuals from other ethnic groups (Levin, 1996). The accessible cues underlying perception of ethnic groups has been addressed in much research. However, there is an ongoing debate on the order of importance of these physical elements. While some authors suggest that perceived racial identification is based primarily on differences in skin colour (e.g., Brown et al., 1998; Dunham et al., 2016), others suggest that various physical characteristics may be equally important in 'race' categorisation (e.g., Brooks & Gwinn, 2010; Stepanova & Strube, 2012).

It is in any case through the use of these physical criteria that the perception of racial categorisation may arise, with some individuals appearing more typical than others. Although a homogeneity bias might lead us to perceive individuals in a racial category as very similar to each other, this does not prevent the identification of typical individuals from 'race' categories. Whether this perceived typicality is based on a stereotypical representation or whether it corresponds to the average individual of that group encountered most often is not clear.

It is precisely this typicality and, by contrast, atypicality that may be interesting to consider in OGRB studies. It reflects the idea that a given ethnic category is not homogeneous and that individuals within it may vary along a continuum of perceived ethnic typicality. Surprisingly, this perceived ethnic variability has not been systematically investigated in intergroup face recognition studies. A large amount of work on OGRB does consider differences between meta-categories, such as ethnic group or 'race', but within-category variability is rarely discussed.

The impact of perceived ethnic variability in social psychology

The issue of perceived ethnic typicality has been addressed in social psychology, and more specifically how it can impact on one's social perception of an individual. For example, one line of research has focused on the impact of ethnic typicality on social identity (e.g., Mitchell et al., 2018; Santos & Updegraff, 2014). In these studies, ethnic typicality, whether self-perceived or perceived by a third party, has been shown to be linked to a stronger or weaker social identification with the ethnic group.

A more important line of research relies on the existence of an attitudinal bias that could be activated by perceived ethnic typicality. Maddox in 2004 reviewed the literature on this phenomenon, that he refers as the '*phenotypicality bias*'. In his work, Maddox highlights the existence of numerous consequences linked to this perceived ethnic variability. In particular, he raises the impact of this typicality on beliefs, feelings, evaluation and treatment of individuals. The bias is also known under other terms, studied across different social science disciplines. It can be found, in particular, under the name of 'colorism', perceptual prejudice, 'skin colour bias' or Afrocentricity (and conversely Eurocentricity).

The study of this phenomenon has its origins in the study of the discriminatory treatment of the African-American slave group in the United States. In particular, there is historical work on the effects of colourism (i.e., differential treatment based on skin colour). The sadly famous paper bag test is a good example. During the slave trade, the privileges of slaves could be defined according to their skin colour. Individuals whose skin colour was lighter than a brown paper bag were given more privileges than those whose skin was darker. These differences in treatment based on physical appearance within a discriminated group have not disappeared and are based on an important history of a 'White' ideal from colonial history (Norwood, 2015).

Maddox defines the phenomenon of phenotypicality bias as follows: individuals assessed as particularly typical of a specific ethnic group will be more likely to be viewed through the prism of the stereotypes, beliefs and prejudices associated with their group. Therefore, within ethnic groups that are discriminated against, individuals may receive differential treatment depending on the extent to which they fit the perceived physical prototype of their group. The more an individual has physical characteristics that lead to being perceived as typical of their group, the more discriminatory treatment they will receive.

The phenotypicality bias and the OGRB

At first sight, this attitudinal bias seems relatively far removed from the own-group recognition bias. However, its study could be an interesting angle. First, and considering the limited amount of work allocated to perceived ethnic variability on face recognition, the study of the phenotypicality bias may be important. It could help to assess how ethnic typicality and variability are conceptualised, manipulated and studied in the social sciences. Therefore, this work could also challenge the way ethnic/racial groups are studied in the OGRB area and suggest a new research angle where ethnic typicality becomes a variable in its own right in the study of the OGRB.

More importantly, its study, and specifically regarding its impact on prejudice, can also be linked to the ecological perspective on social interactions in the OGRB context. Indeed, as expressed in the first part of this thesis, the study of prejudice is central to the understanding of intergroup social interactions. And social contact could play an important role in face recognition. Consequently, the study of the existence of a bias highlighting that within ethnic groups, a perceived ethnic typicality variable could significantly impact the activation of prejudice would be particularly interesting.

In addition to its impact on prejudice, ethnic typicality has also been shown to have an impact on social interactions. A study by Hebl and colleagues (2012) found that typical African individuals tended to have fewer friendships with ethnic groups other than their own compared to their light-skinned counterparts. One explanation for these differences in contact patterns is that highly typical individuals experience greater social rejection and exclusion.

It therefore seems possible to consider the study of phenotypicality bias, and specifically in respect or its impact on prejudice, and OGRB together. This objective was addressed in two steps in what follows. First, I report a systematic review of the impact of ethnic variability, particularly through the study of perceived ethnicity, on the activation of prejudices. This review, although apparently detached from a direct study of face recognition, allowed me to review the conceptualization of ethnic typicality but also to establish its social consequences on the variables of interest in my approach to the OGRB. Finally, in a second chapter in this section, I directly study the effect of ethnic typicality on inter-group recognition abilities while considering the social variables of ethnic prejudice and inter-group social interaction patterns.

Overview of the systematic review

The purpose of this study was to provide a systematic review on the topic of 'phenotypicality bias' in respect to activation of ethnic prejudice. Specifically, I attempted to answer the question "How does perceived within-group variability of physical appearance of other groups affect prejudice towards those groups?". To do this, I used a reproducible methodology, that of the systematic literature review following the guide provided in the work of Siddaway et al. (2019). Several steps were necessary. Based on the question specification above, a search strategy for finding relevant articles had to be put in place, consisting of meticulous and documented searching of databases. Then, a filtering of the articles according to defined exclusion and inclusion criteria was done. Next, a second collection of articles was identified by mining the bibliography of this first selection of work and additional reviews on

the topic. I then extracted, with the aid of a second coder, a coded set of data (e.g., methodological information, main results) for each of the selected articles. This step allowed for a qualitative assessment of the selected works Finally, a narrative synthesis of the main results of the studies identified for review was performed.

Method

Eligibility criteria

Setting inclusion and exclusion criteria was necessary to select the studies that will best address the key questions specified.

Type of studies

In order to be included in this review, research articles needed to be published in English or French. Ideally, it is preferable not to limit the articles to English-language literature only (Grégoire, Derderian, & Le Lorier, 1995). Only empirical scientific studies were considered, whether they were based on laboratory methods or observational protocols. Literature reviews and meta-analyses were not retained but their bibliographies and/or lists of references were drawn on to extend the list of articles for inclusion in the review.

Type of participants

To be included in this review, studies had to involve an adult population of 18 years of age and older. Although there is some literature focusing on the activation of negative attitudes in children to perceived ethnic variation, I decided to focus on an adult population, which is the population studied in the other experimental protocols of this PhD. Indeed, the purpose of this review was also to be able to consider evidence for a link between phenotypicality bias and the OGRB, which I study exclusively in adults.

Another criterion for inclusion of participants was ethnic group. In this review, phenotypicality bias was only investigated from the perspective of the 'White' group[11]. In other words, participants from the studies selected were always 'Whites'. This is particularly relevant

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[11] Please note that for this systematic review, I referred to the same terminology used in the article on which this work was based. Although I mainly used the term 'European' for the other studies presented in this PhD, I believed that this term was not completely appropriate when talking about Whites/Caucasians from the USA. Thus, I am referring mainly to the appellation 'White' and conversely 'Black'.

in the context of this thesis, which presents other studies using the same group of participants. However, studies in which not all participants were 'Whites' were accepted if it was indicated who the majority were. If individual analyses were conducted according to the ethnic group of the participants, only analyses of 'White' participants were included. The way in which the ethnic group of participants was determined was not the subject of inclusion criteria per se, but this element was addressed in the discussion.

Concerning this ethnic group criterion, when the term 'own group' is used in the review it therefore refers to the 'White' group. Conversely, when the term 'other-group' is used, it refers to all other groups studied apart from 'White'. However, it is important to note that phenotypicality bias is not a phenomenon that occurs only among 'Whites' in the perception of other groups, but also between other groups - and within 'non-White' groups. These studies have therefore not been included in this systematic review, but their implication is addressed in the discussion.

Type of outcomes

The key review objective was to observe what has been reported in the literature regarding the impact of perceived ethnic variability on attitudes towards members of other groups. To do this, it was necessary to carefully define what would constitute a study or measure of attitudes. According to the model of attitudes of Zanna and Rempel (1988), an attitude can be defined as a value of judgement or an opinion more or less positive on an object. This judgment can be based on 3 main components: cognitive, affective and conative. However, behavioural attitudes (conative components) are distinct from the other two, particularly because they do not always correspond to affective and cognitive attitudes. Because of this, and because I have considered attitudes in my empirical work primarily on affective and cognitive components, only studies presenting these components of attitude were retained in the review. Consequently, studies assessing the impact of perceived ethnic variability on behaviour (e.g., discriminatory behaviour) were not retained. The key element of interest with respect to attitude was the perception and more specifically the affective or cognitive evaluation by members of a 'White' group of other-group members.

There are many methodologies to measure attitudes, so both direct (e.g, self-report scales, trait evaluation inventories) and indirect (e.g., IAT and priming effects) forms were accepted for review. Studies focusing on attractiveness as an instance of attitudes were not retained. Although attractiveness has been repeatedly shown to impact attitudes and behaviours (see

Adams, 1977 for a review), I did not consider this to be an attitude measure per se. However, work focusing on perceived ethnic typicality and attractiveness was addressed in the discussion.

The second variable of interest was perceived ethnic variation. Here again, a large number of methodologies can be found. For this review, I included all studies studying whether perceived ethnic variability increased or decreased the perceived ethnic typicality of the other-group. As a result, studies that created variation in perceived ethnic typicality by changing a particular physical characteristic (e.g., skin colour or haircut type) or set of physical traits concomitantly (e.g., change in nose and mouth size, skin colour and hair colour) have been retained. Therefore, studies on all types of faces were accepted, whether they were real faces, artificially created faces using software, or drawings. Similarly, different types of perceived ethnic variation were accepted on those stimulus faces, whether they were was an evaluation a priori (from a pilot study for example), or the same face (real or not) artificially modified in such a way as to vary in perceived ethnic typicality. A particular interest was given to the validation of perceived ethnic typicality manipulations used in studies. Although it was not necessary for a study to present a clear manipulation check on variation of perceived ethnic typicality to be included in the review, a report of an absence of such was addressed in the assessment of the studies' quality that is discussed later on.

Finally, perceived ethnic typicality was sometimes operationalised in respect of other variables such as gender or age. The studies assessing the effects of ethnic variation with a covariate have been kept if it was possible in the results section to isolate the impact of the perceived ethnic typicality on attitudes. Besides, only studies presenting analysis on the direct impact of ethnic variation on attitudes were retained.

Information sources

The first search for information sources consisted in a supervised search on the EBSCO server. EBSCO is an online platform that gathers a large database of articles from different journals and publishers. It allows an advanced search with the use of the Boolean search mode (use of operators like "AND" and "OR" between keywords). It also allows one to select the population of interest, language and year of publication, and type of support (i.e., whether it is an article, a book review, a speech etc.).

Searches on the EBSCO platform were conducted via 3 databases: PsycARTICLES and PsychINFO, produced by the American Psychological Association (APA), and the Psychology and Behavioral Sciences Collection produced by EBSCO Publishing. Searching for articles in

multiple databases increases the possibility of obtaining the most comprehensive review possible by overcoming existing indexing differences between databases (Shamseer et al., 2015).

The second major source of information consisted of the mining of the bibliography of articles selected from the database searches and articles not included for systematic review, but which present a review of the literature on the topic of the effects of perceived ethnic variation. Five literature reviews were selected and exploited: Adams et al. (2016); Gullickson (2005); Hall (1992); Maddox (2004) and Maddox and Perry (2018).

Key words

The keyword search on the EBSCO platform was conducted to reflect the concepts addressed by the problem posed. It is possible to enter one or more keywords linked together by Boolean operators and applied in particular fields (e.g., authors' names, present in the whole text, title, etc.). For this review, I used three keywords strung together with the Boolean operator "AND" but for which the search field was not specified. As a result, it was accepted that the three keywords string of search terms could be applied to all fields, thus allowing the widest set of results to be obtained. The chosen keywords cover 3 main concepts: a) racial or ethnic groups, b) perceived ethnic variation, and c) the notion of attitude.

Concept a) resulted in the keywords 'race' and 'ethnic' combined by the Boolean mode "OR". Concept b) is a bit more complex and refers directly to the many terms that are associated with the concept of phenotypicality bias. Maddox (2004) had noted that a significant number of terms exist in the literature to talk about phenotypicality bias. I therefore reused the different terminologies grouped in Maddox's article in order to carry out my search. One can find "phenotypicality"; "phenotypicality bias"; "colourism"; "bleaching syndrome"; "perceptual bias"; "Afrocentricity"; "Afrocentric bias"; "phenotyping"; "skin colour bias"; and "skin tone bias". These keywords reflecting the concept of phenotypicality bias were grouped with the use of the Boolean search mode "OR". Finally, the concept c) groups the terms "prejudice", "attitude" and "stereotypes", combined together with the Boolean operator "OR".

The search for these three keywords strings were combined using the Boolean operator "AND". The final search on the EBSCO host server is illustrated below in Figure 3.1.

Figure 3.1.

Screenshot of the search on the EBSCO host platform using the 3 keyword strings

Protocol

I started the collection of articles by performing a search on the three selected databases (see Information Sources) using the keyword strings described in the previous section. I also established general search parameters and some specific to each database. In the search options, I chose a Boolean/Phrase search mode with the selection "Also search within the full text of the articles" and "Apply equivalent subjects". I didn't apply any of the options of published date in order to get the maximum results possible for any period of time. In the option of the APA PsycArticles, I did not specify a date or publication status (First posting or Fully Published). All publishers were selected, as well as document types, classification codes and additional material. For age groups, I selected the category "Adulthood (18 years and older)" and the population group "Human" only. In the option of APA PsycInfo database, I, here again, did not specify publication year limitations or public status. I did select all supplemental materials, publication type, intended audience, book and document type and classification codes. Then, I did select the age group "Adulthood (18 years and older)" with "Human" population only. The languages selected were both "English'' and "French"[12]. Finally in the option for the Psychology and Behavioral Sciences Collections database, a very limited number of options were available. I chose all types of document, without any limitations.

In order to give a summary account of the work of selecting the articles, a flow diagram is shown to retrace the process of collection of the articles as a function of the searching method (Figure 3.2). The detailed explanation of the different steps is described below.

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[12] Although no research articles published in French were found

Figure 3.2.

Flow diagram of the collection of articles through database research and mining of references

| Identification of studies via databases and registers | | Identification of studies via other methods |

Identification

Records identified from:
    Database APA PsychArticle
    (n = 171)
    Database APA PsycInfo (n = 99)
    Database Behavioral (n = 361)

Records removed *before screening*:
    Duplicate records removed (n = 0)

Records identified from:
    Citation searching (n = 11)

Screening

Records screened (n = 631)

Records excluded (n = 612)

Reports sought for retrieval (n = 19)

Reports not retrieved (n = 3)

Reports sought for retrieval (n = 11)

Reports not retrieved (n = 2)

Reports assessed for eligibility (n = 16)

Reports excluded (n =8) :
    No measure of attitudes (n = 2)
    No manipulation of phenotypic variability (n = 2)
    No data on direct effect of phenotypicality on attitudes (n = 3)
    Not White participant (n =1)

Reports assessed for eligibility (n = 9)

Reports excluded:
    Do measure of attitudes (n = 2)
    No manipulation of phenotypical variability (n = 1)

Included

Reports included in review from database research (n = 8)
Reports included in review from citation searching. (n = 6)
TOTAL = 14 included articles

Note. Based on Page et al. (2021).

631 results were retrieved. For each result, I screened the title and abstract, and when necessary, I also checked the information in the body of the text to ensure compliance with the inclusion and exclusion criteria. Following this initial screening, 19 works were selected.

In a second step, I collected and screened the content of the 19 research documents indexed in the search results (17 published scientific articles and 3 PhD theses). The 3 PhD manuscripts were not available as open access or through the journal subscriptions held by my Universities. Individual requests were made to the concerned authors to obtain the unpublished manuscripts. No response was obtained from the authors, so the theses concerned could not be included in this systematic review. The remaining 16 published articles were analyzed to ensure the satisfactory quality of their content. In particular, I evaluated the treatment of the perceived ethnic typicality and attitude assessment variables. After analysis, 8 articles were discarded, and 8 were retained. Details of the articles included and excluded in these different stages are given in Appendix J.

A second research method was then used. Based on analysis of the bibliography of the 8 articles previously selected as well as five reviews of the literature on phenotypicality bias (Adams et al., 2016 , Gullickson, 2005; Hall, 1992; Maddox, 2004; Maddox & Perry, 2018), I was able to retrieve additional works that could be included in the final review. 11 research works were selected (including one unpublished PhD thesis) from this bibliography mining. Two works were not available for reading (including the Phd) and requests were made for these manuscripts but no response was obtained from the authors. The remaining nine articles were analyzed in terms of quality and three articles were discarded in this respect. Thus, six scientific articles were selected from this bibliographic search. A detailed table of the included and excluded articles from this research method is available Appendix K.

In total, 14 scientific articles were thus selected for this systematic review covering a period of 20 years of research (2002 to 2021) and are detailed in Table 3.1.

Table 3.1.

Dates, Authors and Title of the articles synthesised in the Systematic Review

Date	Authors	Title
2006	Blair	The efficient use of race and afrocentric features in inverted faces.
2002	Blair et al.	The role of afrocentric features in person perception: judging by features and categories
2004	Blair et al.	The automaticity of race and afrocentric facial features in social judgment
2018	Cowart & Lehnert	Empirical evidence of the effect of colourism on customer evaluations
2020	Deska et al.	Black racial phenotypicality shapes social pain and support judgements
2012	Hagiwara et al.	The independent effects of skin tone and facial features on Whites' affective reactions to Black
2014	Hannon	Hispanic respondent intelligence level and skin tone: interviewer perceptions from the 86abelled national election study
2021	Kurdi et al.	Specificity and incremental predictive validity of implicit attitudes: studies of a race-based phenotype
2002	Livingston & Brewer	What are we really priming ? Cue-based versus category-based processing of facial stimuli
2018	Ma et al.	The effects of category and physical features on stereotyping and evaluation
2002	Maddox & Gray	Cognitive representations of Black Americans: re-exploring the role of skin tone
2015	Opie & Phillips	Hair penalties: the negative influence of afrocentric hair on ratings of Black women's dominance and professionalism
2012b	Stepanova & Strube	What's in a face? The role of skin tone, facial physiognomy, and colour presentation mode of facial primes in affective priming effect
2019	Williams et al.	The face of STEM: racial phenotypic stereotypicality predicts STEM persistence by- and ability attributions about-students of colour

Quality assessment

Before proceeding to the synthesis of the set of studies, it was necessary to set up a data extraction within each article. This data extraction was carried out using a double coding method. The data to be extracted were defined beforehand between the second coder and myself and included: the year, the title and the names of the authors of the article in question, then the sample size (as well as the excluded data), the gender and the status of the participants, the number of experiments, the type of perceived ethnic typicality manipulation as well as its manipulation check, the type of attitude measurement and finally the type and kind of stimuli used. Those data are gathered in Table 3.2. In a second step, the two coders also reported the main effects of the perceived ethnic typicality manipulation on the attitude measure for each of the experiments presented in the papers. These data in particular were used in the narrative review but are not present in Table 3.2. Together with the second coder, we established, with the help of a guiding article, how to extract the data and then coded the remaining 13 articles independently. Once this was done, the data extracted was pooled.

The extraction of these data allows, among other things, to establish a qualitative appraisal of the selected articles (see Table 3.2). These data make it possible to put methodological elements into perspective and to appreciate their positive aspects but also their limitations. In this systematic review, the assessment of the quality of the studies did not lead to the exclusion of additional articles. These qualitative elements were used to add nuance to the reported results but also to address in the discussion the generalization of these results to the population and a range of contexts. Throughout this review, reference will therefore be made to those specific qualitative elements, mainly of a methodological nature.

Table 3.2

Elements of quality appraisal per article

Article	Number of experiments	Number of participants*	Excluded data	Gender participant	Status participant	Type of attitudes measure	Type of perceived ethnic variation*[1]	Manipulation check of ethnic variation	Stimuli type	Stimuli gender
Blair (2006)	1	119	2	Na	Student	Adhesion to counter- vs stereotypic description	Ratings of Afrocentricity	Yes	Real face photos	Men
Blair et al. (2002)	3	93	3	40% female 60% female	Student	Adhesion to counter- vs stereotypic description	Ratings of Afrocentricity	Yes	Real face photos	Men
Blair et al. (2004)	4	302	10	63% female 37% male	Student	Adhesion to counter- vs stereotypic description	Ratings of Afrocentricity	Yes	Real face photos	Men
Cowart & Lehnert (2018)	3	456	11	Na	Not student	Attribution of traits	Skin colour manipulation (via software)	Yes	Real face photos	Men & Women
Deska et al. (2020)	5	1064	Na	53% female 47% male	Na	Attribution of traits	Ratings of ethnic typicality	Yes	Real face photos	Men
Hagiwara et al. (2012)	1	186	10	Na	Na	Implicit (automatic affective reaction) and explicit liking	Skin colour and facial traits manipulation (via software)	Yes	Real face photos	Men
Hannon (2014)	1	459	Na	Na	Na	Attribution of traits	Skin colour perception	No	Real person in face to face settings	Men & Women

Kurdi et al. (2021)	5	2784	1134	69% female 31% male	Na	Implicit measure (IAT) and explicit measure (trait rating)	Haircut manipulation	No	Drawing	Women
Livingston & Brewer (2002)	5	298	46	58% female 42% male	Student	Implicit measure (affective priming task)	Ratings of ethnic typicality	Yes	Real face photos	Men
Ma et al. (2018)	1	81	Na	73% female 27 % male	Student	Implicit measure (Lexical Decision Task)	Ratings of ethnic typicality	Yes	Real face photos	Men
Maddox & Gray (2002)	1	42	Na	52% female 48% male	Student	Stereotypes listing	Skin colour description	No	Category description	Men & Women
Opie & Phillips (2015	3	604	Na	Na	Not student	Attribution of traits	Haircut manipulation (via software)	No	Real face photos	Women
Stepanova & Strube (2012, b)	1	106	Na	62% female 38% male	Student	Implicit measure (affective priming task)	Skin colour and facial traits manipulation (via software)	Yes	Synthetic faces	Men
Williams et al. (2019)	3	923	Na	65% female 35% male	Not student	Attribution of traits	Ratings of ethnic typicality	Yes	Real face photos	Men & Women

* Number of participants do not include the excluded data

*[1] Rating of Afrocentricity refers to a ethnic typicality rating but only for African individuals. Rating of ethnic typicality refers to ratings of the ethnic typicality for the different groups studied (e.g., European, African, Asian..)

Note. The criteria for assessing the quality of these studies were selected in consultation with the second coder. These criteria are not exhaustive and their limitation are mentioned in the discussion.

Careful reading of the articles and the coding process lead to a number of observations. First of all, there is a multiplicity of terminologies to address ethnic groups. In particular, one can find the classification 'White' and 'Black' and sometimes also 'European', 'Caucasian', 'Afro-American', 'Hispanic', 'Latino'. Similarly, perceived ethnic variability is not consistently addressed in the same way. Terminologies such as 'prototypicality', 'phenotypicality', ethnic typicality and 'phenotypic variation' are found. One can postulate that these terminologies address the same groups and phenomena although using differences in language. However, it is clear that the way in which this perceived ethnic typicality is manipulated varies greatly. I will use mainly the terminology "perceived ethnic typicality"

Another element concerns the way measure of attitudes was considered, here again, the conceptualisation of this variable has been very different from one article to another. This variation contra-indicates including a meta-analytical component to this systematic review. From this coding it was established that this review would consist of a synthetic narrative approach only. It can also be noted that not all studies systematically validated the perceived ethnic variation, which could be considered as a major detriment to the quality of this work.

Finally, an important qualitative point concerns the external validity of all the studies included in this review. There is a general tendency for the experimental samples to be almost equally divided between men and women and for half of the studies to be non-student. There is also a wide range of sample sizes, from 30 participants per protocol in the Blair et al. study (2002) to around 556 participants per experiment in the Kurdi et al. study (2021). These differences are partly based on different methodologies and statistical choices that do not have the same constraints. However, these choices remain open to criticism and may reflect lower quality in either case.

With regard to the type of stimuli used in these studies, an important element lies in the gender chosen. More than half of the studies concerned an ethnic typicality manipulation on male faces only, compared to two for female faces. Furthermore, the studies focusing on female ethnic typicality are exclusively on the manipulation of one physical characteristic, namely hair, which did not benefit from a manipulation check. It is therefore possible that in addition to a smaller body of work for women, there are also studies of questionable quality. The implications of this focus in the literature on the near-exclusivity of men will be addressed in more detail in the discussion.

Narrative Review

This systematic review considered a relatively limited number of studies using very different methodologies. As expressed by the previous qualitative assessment of studies, a multiplicity of methods was used to measure variables of interest. One can find various conceptions of what constitutes the perceived ethnic typicality of a group. There is a dichotomy between work that focuses on skin colour and that which focuses on facial characteristics. This division reflects the debate in the literature about what constitutes the primary component of a group's perceived ethnic variability. Some authors argue that a perceived ethnic variability is primarily a function of skin colour (Brown et al., 1998). Thus, manipulation of skin tone (e.g., from very light to very dark) is considered sufficient by some authors to cause variation in perceived ethnic typicality. Other authors, however, suggest that it is also a function of facial characteristics (e.g., variation in facial features, or morphology, such as lip fullness, or nose width). Thus, some of the literature has treated facial features and skin colour concomitantly, arguing that these elements coincide and can be labelled, when specific to African faces, as defining a dimension of "Afrocentricity" (Blair et al., 2002). Others postulate that, while important to study together, they nonetheless have distinct and independent effects on attitudes (Hagiwara et al., 2012).

But beyond this difference between facial features and skin colour, there were also methodological differences in the medium in which the perceived ethnic typicality was presented. Some studies presented photos, drawings or videos of individuals with varying ethnic typicality (whether the manipulation was artificial or the result of an upstream assessment of typicality), and others offered descriptions of individuals without presenting visual support such as photos.

There was also a multiplicity of methodologies used to report on attitudes. This may be due to the definition of the term 'attitudes' itself, which may include different elements depending on the authors' purpose and scientific background. Some studies under review focused on the activation of group-specific stereotypes (Blair et al., 2002; Blair et al., 2004; Blair, 2006; Ma et al., 2018; Maddox & Gray, 2002), and others on attribution of traits in a global context (Deska et al., 2020; Hannon, 2014) or in particular situations (Cowart & Lehnert, 2018; Opie & Phillips, 2015; Williams et al., 2019). Another part of the literature has instead focused on affective reactions, as assessed with implicit (Livingston & Brewer, 2002; Stepanova & Strube, 2012b) and/or explicit (Hagiwara et al., 2012; Kurdi et al., 2021) measures.

Afrocentric features and stereotype activation

As mentioned above, studies on the phenotypicality bias can be divided into groups taking several methodological and conceptual approaches. One of them is the study of perceived ethnic typicality and its impact on the activation of racial stereotypes. Maddox and Gray (2002) developed a research protocol highlighting a difference in stereotype attribution based on skin colour of 'Black' target faces. They asked participants to list stereotypical traits (negative, neutral and positive) for different individuals whose skin tone varied from dark-black (high ethnic typicality) to light-black (low ethnic typicality). Their results show that 'Black' individuals with darker skin tone were associated with more negative stereotypical traits compared to light skinned 'Blacks' who were more associated with positive traits. This study is an important contribution that demonstrates that variation in skin colour within the same stigmatized group does not elicit the same attitudes.

In the continuity of this work, a research team led by Irene Blair developed a set of protocols on this topic showing how facial features and skin colour can jointly activate group-specific stereotypes that vary in strength. These authors suggested the terminology "afrocentric features" to refer to stereotypical African skin colour and facial features. From their early work, they hypothesized that the more afrocentric physical characteristics individuals possess, the more likely it is that stereotypically African traits will be attributed to them. In three articles, Blair and her collaborators therefore set out to test the effects of afrocentric features in person perceptions (Blair et al., 2002), then to test the automaticity of this phenomenon (Blair et al., 2004) and finally its potency (Blair, 2006).

In a first article, Blair et al. (2002) validated their photographic material by having a set of photographs of European and African men evaluated on characteristics of Eurocentricity and Afrocentricity. Each face was assigned a score assessing the extent to which it represents a typical European/African individual. In order to test their hypothesis about the effect of afrocentric characteristics, Blair et al. (2002) developed a specific methodology that was designed to avoid an explicit demand for trait attribution. To do this, they created four profiles describing a young man along two distinct dimensions: the extent to which the individual described possessed stereotypical African traits and the extent to which he appeared to be sympathetic/likeable. Thus, they presented two stereotypical and two counter-stereotypical descriptions, each valenced either positively (likeable) or negatively (not likeable). For each description, the participant was asked to evaluate a set of face photos and to determine how

well the individual matched the description. Through three experiments, Blair et al. (2002) found that individuals with afrocentric characteristics were more strongly associated with stereotypical descriptions. These results were demonstrated for faces categorized as African, specifically for negatively valenced descriptions (Study 2) and for those categorized as European (Study 3), and were replicated with the use of other descriptive texts for African and European targets (Study 4). Moreover, this effect of afrocentric features was found even when controlling for attractiveness and accessibility of the target faces' racial category (studies 2- 4).

In another article, Blair et al. (2004) reproduced the methodology developed in the work of Blair et al. (2002) described above. They re-used the same process of associating a short, more or less stereotypical descriptive text with a face stimulus varying in perceived ethnic typicality. Although this time, the objective was to demonstrate the automaticity of the phenomenon presented above. Through four experiments, the authors reproduced the same phenomenon shown in the previous set of studies: individuals (European or African) with afrocentric characteristics were statistically more strongly associated with stereotypical descriptions and particularly with negative stereotypical descriptions, but this was true for African individuals only. Blair et al. also demonstrated that this process remained unchanged even when cognitive resources were restricted (Study 1) or when specific instructions were offered to participants to limit stereotype association with individuals with afrocentric characteristics (Study 2-4). This paper not only replicated the results of a phenotypicality/Afrocentricity bias but also demonstrated its automatic and poorly controllable nature.

In addition, in a 2006 study, Blair replicated this protocol again with African targets to test the effectiveness of the bias. To do so, she used the same task but with an alteration of the faces (presented upright or inverted). This manipulation of the target was intended to assess the degree of robustness of this effect. The inversion process did not disturb the effects of afrocentric features on stereotype activation.

More recently and using an implicit measure (Lexical Decision Task), Ma et al. (2018) assessed the impact of three levels (low, average and high) of perceived ethnic typicality of 'Black' and 'White' targets on stereotype activation. An illustration of the stimuli used in this experiment is presented in Figure 3.3. Their results confirmed research to date, namely, greater activation of negative stereotypes with increasing perceived ethnic typicality of targets. However, they also showed that it is the faces with average ethnic typicality (see Figure 3.3 for an example) that activated stereotypes (positive and negative) the most. Thus, individuals perceived as highly typicaly could activate more negative attitudes but others perceived as

Figure 3.3.

Face stimuli used in Ma et al.'s (2018) experiments varying on an axis of ethnic typicality

Racial Prototypicality
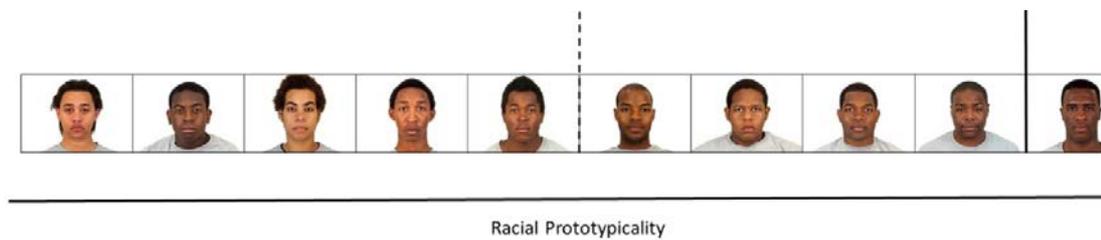
Note. This illustration was extracted from Ma et al. (2018) article and represents example of real African faces stimuli used in their experiment. Photograph are from the Chicago Face Database (Ma et al., 2015) which presents for each stimulus an evaluation of ethnic typicality.The African ethnic typicality is allegedly increasing from left to right. The dotted line represents the theoretical average

average in ethnic typicality could be associated more with positive and negative stereotypes characterizing their group in general. These results could lead to consider the study of within-group variation beyond a dichotomy between high perceived typicality and low perceived typicality, and thus not to omit that perceived typicality is in fact a continuum.

Through 10 studies, Blair and her co-authors repeatedly demonstrated that perceived ethnic variation, manipulated by skin colour (Maddox & Gray, 2002) or by physical characteristics and skin colour (Blair et al., 2002; Blair et al., 2004; Blair, 2006; Ma et al., 2018) had a significant impact on people's attribution of ethnic stereotypes . An individual presenting with facial characteristics typical of a given group (here African) will be perceived to have the stereotypes typically attributed to this group. And more importantly, in the case of African targets, it was the negative stereotypes that were more strongly activated. In other words, perceived ethnic typicality modifies the perception that an observer may have of an individual. This perception becomes more stereotypical with the presentation of afrocentric characteristics and more negatively stereotypical in the case of African individuals with afrocentric characteristics. This phenomenon has been reported to be independent of categorical accessibility and perceived attractiveness (Blair et al., 2002) but also as being automatic (Blair et al., 2004) and potent (Blair, 2006).

Perceived ethnic typicality and evaluation of traits

Figure 3.4.

Illustration of 4 stimuli faces used in Deska et al.'s (2020) study

Note. Illustration extracted from the article of Deska et al. (2020). Those photos represent real face photographs and were selected from the Chicago Face Database (Ma et al., 2015). Individuals in the right panel represent high ethnic typicality, and in the left, low ethnic typicality

Another research tradition has been to study trait attribution as a function of perceived ethnic typicality. In 2014, Hannon looked at attribution of the trait "intelligence" based on skin colour the skin colour was of the targets, the less intelligent he or she was perceived to be by the observers. Conversely, light-skinned Hispanics were up to 5 times more likely to be considered "highly intelligent" than their lighter-skin counterparts.

More recently, Deska et al. (2020) demonstrated in five experiments that 'Black' and 'White' individuals with high levels of African ethnic typicality were found to experience less social pain than individuals with low levels of African ethnic typicality. An illustration of the stimuli used in those experiments in presented Figure 3.4. This effect is thought to be due to the belief that highly typical African ethnic typicality individuals are more resilient and tough.

In a work context, Opie and Phillips (2015) demonstrated that women with typical African or European haircuts were not viewed in the same way in the workplace. Indeed, they demonstrated through three studies that women with a typical African haircut were evaluated as less professional than women with a typically European haircut. Surprisingly, in the same context, light-skinned Hispanic men were evaluated as less competent, efficient, and hardworking than their dark-skinned counterparts (Cowart & Lehnert, 2018).

In an educational context, a study on STEM academic programmes (Science, Technology, Engineering, and Mathematics), reported that students were evaluated as having different STEM-related abilities (smart, good at math and physics, good at computers and engineering) as a function of the perceived typicality level of their ethnic group (Williams et al., 2019). Asian students (women and men) of high ethnic typicality were judged to have better STEM-related abilities compared to their low ethnically typical level counterparts. Conversely, African women – not men- students were judged to be less intelligent and less competent at math, physics, engineering, and computer science when they were perceived highly typical of their ethnic group compared to low typicality individuals. These results were found when participants were from the general 'White' public (Study 2) or were 'White' supervisors in STEM fields of study (Study 3). Regarding the gender difference in perception of STEM-related abilities of African students, the authors suggested that this reflects a greater motivation to control stereotypes towards African men compared to African women. Participants would be more aware of the activation of phenotypic-based stereotypes when concerning men, and therefore would have more control over their response to not allow their stereotypes to show (Study 4).

Studies of trait attribution as a function of perceived ethnic typicality confirmed that within a stigmatised group, individuals are not evaluated in the same way based on their perceived ethnic typicality. Hispanic perceived as highly typical are perceived as less intelligent than their light-skinned counterpart (Hannon, 2014) and yet are evaluated in the workplace as more competent, efficient, and hardworking (Cowart & Lehnert, 2018). African perceived as highly typical, on the other hand, are evaluated as more resilient, tough, and therefore perceived as suffering socially less than their light-skinned counterparts. Finally, African women manifesting high ethnic typicality are perceived as less professional (Opie & Phillips, 2015) and as possessing fewer STEM-related abilities than African women with low ethnic typicality (Williams et al., 2019).

Perceived ethnic typicality and affective attitudes

In this final section of the review, I will examine how perceived ethnic typicality can impact observers' affective attitudes using explicit but also indirect measures of attitudes.

Figure 3.5.

Illustration of the synthetic stimuli used in Stepanova and Strube (2012b)
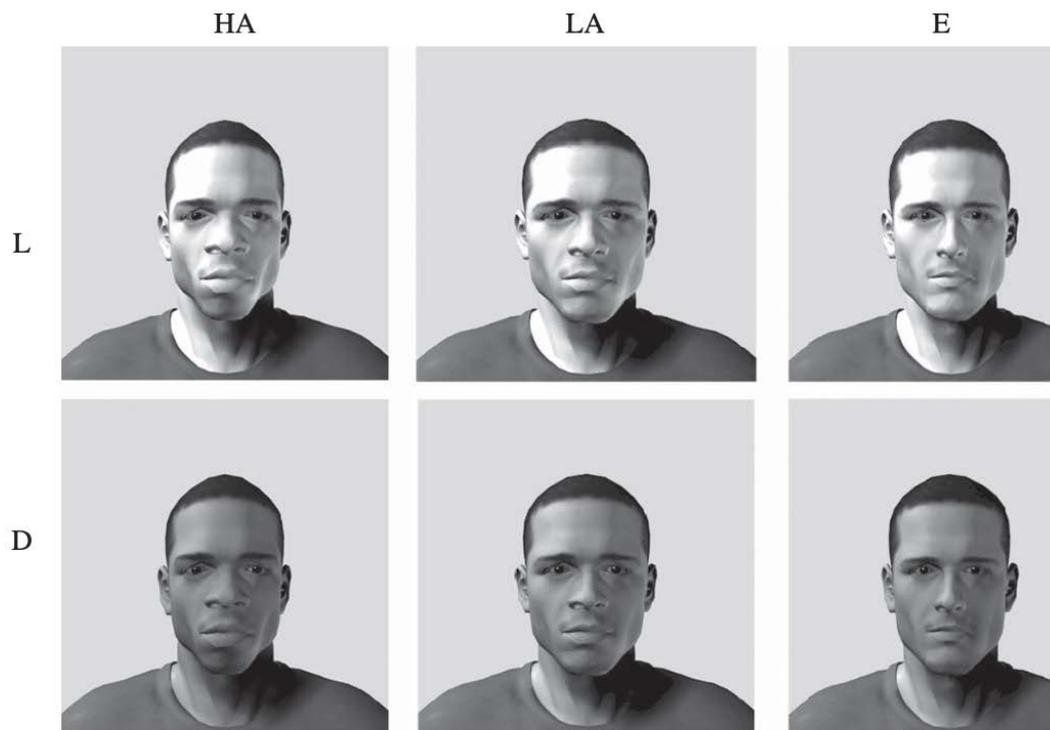
Note. This stimuli illustration was extracted from Stepanova and Strube (2012b) article. The original items were adapted from the work of Stepanova and Strube (2009).

HA = High Afrocentric facial physiognomy ; LA = Low Afrocentric facial physiognomy;

E= Eurocentric physiognomy

L = Light skin tone; D = Dark skin tone

Livingston and Brewer (2002) conducted a series of studies to show the impact of 'Black' perceived ethnic variability on the evaluation of individuals. To do this, they used an affective priming task, which is used to elicit implicit measures of attitudes and stereotypes (see Wittenbrink, 2007, for a review). In the affective priming task, the participant is presented with a visual stimulus, in this case 'Black' or 'White' faces (the prime), and then a word, valenced positively or negatively (the target). The participant has to decide for each target word whether he/she gives a "good" or a "bad" evaluation to this word. The error rate and decision time for

each response are measured. When the target word and the prime have the same valence, then the correct response should be facilitated, conversely if the target and the prime do not have the same valence, then correct responses should be inhibited. Their results showed a difference in the response pattern between low-typicality 'Blacks' and 'Whites' on the one hand, and high typicality 'Blacks' on the other. Low-typical 'Black' and 'White' targets induced higher facilitation to positive words and less facilitation for negative words compared to highly typical 'Blacks' (study 1). And this effect was not due to a wrong categorization of low typicality 'Blacks' as 'Whites' (study 2). Highly typical 'Black' people were perceived more negatively than their light-skinned counterparts, and interestingly, the low-typical 'Blacks' were even eliciting positive attitudes to an extent similar as for 'Whites'.

Stepanova and Strube (2012b) replicated the protocols of Livingston and Brewer (2002) with the same methods of priming and the use of the same words. However, they included a different perceived ethnic typicality manipulation by using synthetic photographs with computer alterations of the faces (see Figure 3.5). In doing so, they created several categories of faces by altering either skin colour (from dark to light) and afrocentric facial features in order to assess the impact of varying skin colour independently of facial features on attitudes. Results suggested that skin tone and features act independently on attitudes. More afrocentric features and darker skin elicited more negative attitudes than eurocentric features and lighter skin. Combined, those two elements also induced a differentiation on attitude activation. Dark skin targets with afrocentric features were treated more negatively than other groups of faces and conversely light skinned targets with eurocentric features were treated more positively than any other group of faces.

Those results were reproduced by Hagiwara et al. (2012) with real photos, whose ethnic typicality was manipulated on software. Both skin tone and facial features independently affected attitudes and those effects were also additive, the dark skinned with highly typical features individuals being the most negatively evaluated. This study also provided an additional explicit measurement of attitudes. The same patterns of results were found as with the affective priming task.

Figure 3.6.

Illustration of the stimuli used in Kurdi et al. (2021)
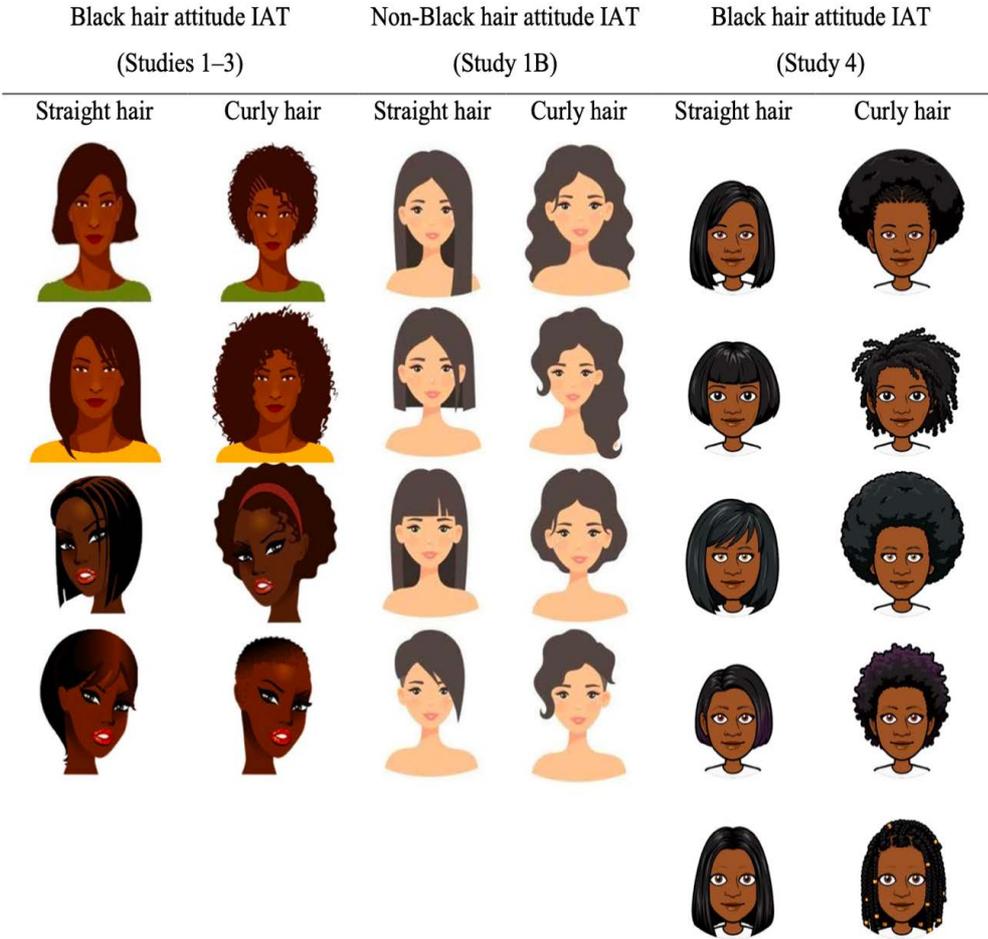
Note. This illustration was directly extracted from the article of Kurdi et al. (2021).

In this article the straight hairstyle was considered as representing an eurocentric feature. Conversely the curly hairstyle was considered as representing an afrocentric feature.

More recently, another article using both indirect and direct attitude measurement was reported by Kurdi et al. (2021). Through several studies they wished to evaluate the impact of an isolated characteristic, haircut on attitudes. To do this, they used a set of sketches of black and 'White' women where the haircut was modified to correspond to either an afrocentric cut (curly) or a eurocentric cut (straight) (see Figure 3.6 for an illustration). They rated their attitudes implicitly, with an IAT, and explicitly, with a trait rating scale. Their results suggested a greater implicit preference for women's faces with eurocentric haircuts compared to Afrocentric haircuts (study 1a,1b, 3 and 4) and for both 'White' and 'Black' faces, although the effect was stronger for 'Blacks'. Those results were shown to not be related to any racial or aesthetic preference (study 2). However, the same results were not obtained with explicit

measurement. Explicit measures of attitudes showed either no difference of appreciation between afrocentric or eurocentric targets (study 2 and 3) or a preference for the afrocentric hair targets (study 4). The authors suggested that this difference of evaluation between the explicit and implicit measurement could be explained by a greater control of prejudice and higher social desirability bias when it comes to supplementing the explicit measurements.

Overall, these studies show that perceived ethnic typicality does have an impact on affective evaluation. Through different manipulations of the perceived ethnic typicality, one can note a more negative implicit evaluation towards highly typical individuals. Studies by Stepanova and Strube (2012b) and Hagiwara et al. (2012) also tell us that perceived ethnic typicality can be divided into two elements (skin colour and facial characteristics) that act independently on attitudes. Finally, the impact of the perceived ethnic typicality on explicit measures is not as clear. One can find both results similar to what is obtained with implicit measures (Hagiwara et al. 2012) and sometimes an absence of effect or even an inverted pattern (Kurdi et al., 2021). One could explain this by the fact that direct attitude assessment has some limitations. Individuals can sometimes consciously stereotype a group. Social norms and "political correctness" then cause individuals to limit the expression of these negative attitudes (Tankard & Paluck, 2016). In particular, studies show that 'White' US citizens have become increasingly reluctant to express their attitudes toward other ethnic groups (Charlesworth & Banaji, 2019; Nosek et al., 2009). The advantage of implicit measures is that they are more indirect, so the participant is not necessarily aware that these attitudes toward a specific object are being assessed. Although there is no good evidence, as far as I know, for "unconscious"/"unaware" attitudes (Gawronski, et al., 2022). In particular, this limits the control the participant may have over their attitudes, which could be related to social desirability (De Houwer, 2006). It could also reveal attitudes that the participant is not aware of.

Discussion

Through this systematic review of the literature, it is possible to assess the impact of perceived ethnic typicality on intergroup attitudes. Firstly, studies on the activation of racial stereotypes show that individuals who are particularly typical of the 'African/Black' group will be more strongly associated with stereotypes of this group, especially negative ones. There is thus a within-group variation in the activation of racial stereotypes, conditioned by physical characteristics. This effect is also partially found in 'White' individuals with afrocentric characteristics, with a higher activation of African group stereotypes for these individuals than for 'Whites' with eurocentric characteristics.

Second, another group of studies shows that within-group variation also conditions the attribution of traits. Whether within the Hispanic or African group, differences in trait attribution are found according to the perceived ethnic typicality of the individual. These trait attributions reflect the stereotypes underlying the different racial categories and are generally negative.

Finally, studies of participants' affective attitudes show a more negative implicit and sometimes explicit evaluation of individuals with afrocentric characteristics (whether defined by skin colour, facial features or both). Again, these results are also found among 'White' individuals with Afrocentric characteristics, but to a lesser extent.

In conclusion, perceived ethnic typicality impacts on attitudes through a number of different elements. In general, individuals with characteristics typical of a stigmatised group (such as 'Blacks' or 'Hispanics') will tend to have racial stereotypes associated with the group in question activated in a 'White' observer. The resulting affective or cognitive evaluation is generally more negative for these individuals than for their counterparts with characteristics less typical of the group discriminated against, or more typical of the dominant group ('Whites').

This review also informs us about the very conception of within-group variation. From an important tradition of research on colorism (discrimination based on skin colour), skin colour has been considered by many researchers as one, if not the, most important criterion for reflecting ethnic typicality. However, several studies show the importance of considering elements of ethnic typicality beyond skin colour. Some have considered perceived ethnic typicality as a single body characteristic modifying attitudes (e.g., Blair et al., 2002; Deska et al., 2020; Livingston & Brewer, 2002), others have rather considered that skin colour and facial characteristics play a similar but independent role in affecting attitudes (Hagiwara et al., 2012; Stepanova & Strube, 2012b) and finally, others have explored the isolated impact of facial characteristics such as hair (Kurdi et al., 2021; Opie & Phillips, 2015). Overall, this work raises the importance of questioning the notion of within-group variability and ensuring manipulations that would best reflect the possible phenotypes found in an ecological environment.

It is also noted on several occasions in these presented articles that contrary to racial prejudices, those based on within-group variability are not conscious. This would make the phenotypicality bias particularly robust and potent. This notion is particularly important because it defines the ability to control this bias. Monteith and Mark (2005) note in their review that awareness is the most important first step in overcoming prejudice. If the prejudices linked

to perceived ethnic typicality are not made aware then it becomes more difficult to overcome them. However, Blair et al. (2004) suggest that intensive training could make this phenomenon reversible.

Limitations and future direction

Some elements in this systematic review need to be addressed. First, concerning the method used in this systematic review, the exploration of the articles was carried out on three databases. It could be envisaged to continue this effort on a larger number of platforms. An additional effort could be made to explore the grey literature, which was under-exploited in this review. Finally, communication strategies could have been put in place with leading authors in the field (such as Blair or Maddox) in order to retrieve published or unpublished work through a more indirect channel. However, it should be noted that several authors were contacted in order to obtain their unpublished work and that no response from any of these authors was obtained. One can also underline that the assessment of the quality of the articles was satisfactory but could have been made up of more elements such as a reflection on the statistical choices for each protocol or the presence of the sample justification that could have added further elements to discuss, in particular to appraise the weight that should be given to some studies compared to others.

Then, a point must be made on the fact that 100% of the studies included in this review are from US researchers. To my knowledge, there is no research corresponding to my eligibility criteria outside the USA. This leads to a second limitation relating to the groups studied in these articles. Due to their history, Americans have a long tradition of research of prejudice towards Afro-American groups. In this review of 14 studies, 10 present the impact of skin colour or Afrocentricity on the perception of 'Black' people. Only two studies report experiments considering Hispanics and their ethnic typicality and one study reports the simultaneous study of Asians and Afro-Americans. It leaves no doubt that this literature will benefit from further research to include more protocols on diverse minority groups and populations.

As expressed in the appraisal of the articles' quality, one can note a majority of studies focusing on male stimuli only. However, it has been shown more recently that a gender difference could also be at play in the impact of perceived ethnic typicality on attitudes (Williams et al., 2019). In addition, the concept of perceived ethnic typicality may not be based on the same elements depending on gender (e.g., the importance of the haircut in the evaluation of the Afrocentricity of 'Black' women). These elements suggest that particular attention should

be given in future research to the impact of gender on the study of phenotypicality bias and that additional research should be conducted on stimuli that include women.

Still relating to the types of stimuli used, one can find a multiplicity of media, be it photos, face-to-face individuals, drawings or descriptions (see Figure 3.3, 3.4, 3.5, and 3.6, for examples). One may wonder whether the protocols proposing drawn stimuli or descriptions are comparable to those using a photographic medium, especially when it is highlighted that these first types of media generally do not benefit from any manipulation check. Particular attention should be paid to the validation of the material, especially when the very concept under investigation, i.e., perceived ethnic typicality, is based on a notion of subjective perception. Although authors who do not use manipulations rely on an empirical approach to justify their material (e.g., dark skin is perceived as more typical of African-Americans), the impact of the researcher's own perception should not be underestimated.

The study of this phenomenon is relatively recent and has not attracted systematic attention from social psychology. As a result, few studies are available for review at the moment, and those that are available use very different methodologies, making it difficult to conduct statistical meta-analysis.

Implication of the phenotypicality bias

Although the objective of this review was to assess the impact of perceived ethnic typicality on cross-group attitudes, it is interesting to note that this phenomenon is also found within stigmatized groups and that self-reported measures of discrimination reflect a perceived inequality of treatment between low and high ethnic typicality individuals (e.g., Capielo Rosario et al., 2021; Keith et al., 2017; Tran et al., 2017; Uzogara & Jackson, 2016).

In addition, a large proportion of studies in this literature, not covered in this review, has focused on the impact of perceived ethnic typicality on other elements than attitudes. Regarding attractiveness, Vera Cruz (2018), for example, found that light-skinned African individuals were judged more attractive than their darker-skinned peers. But there is a much larger body of work even, on the impact of perceived ethnic typicality on behaviour. Studies present in particular the impact of perceived ethnic typicality on academic success (Kim & Caldaza, 2018), the use of force by the police (Kahn et al., 2016), social rejection (Hebl et al., 2012) and health (Lee & Thai, 2015; Stewart et al., 2020). In the legal community, there is an important tradition of work on the length of sentences (Petersen, 2016), the type of conviction (Blair et al., 2004; King & Johnson, 2016), and the proportion of death sentences (Eberhardt et

al., 2006), as a function of perceived ethnic typicality, mainly among 'Black' defendants. This list is of course not exhaustive and the repercussions of the phenotypicality bias is found in many social contexts.

Through this review and also taking into consideration the impact that perceived ethnic typicality can have on behaviours, it seems important to reconsider the notion of racial group. Indeed, to consider racial/ethnic groups as clearly defined and homogeneous would be to disregard within-group variability, which, as seen, acts in more than one respect. It would be preferable to treat racial categories as continuous rather than categorical, and to consider that within the same groups the attitudinal and behavioural reactions may vary. This element could also be particularly important to take into account in designing anti-discrimination policies. If an effort is observed regarding the integration of policies aimed at reducing discrimination between ethnic categories, this does not however prevent the activation of stereotypes within the categories themselves. For example, if one develop policies for the integration of 'Black' African individuals in a particular area (like media representations), it remains important to be careful not to favour only a part of this population, towards whom the attitudes of 'Whites' would generally be more favourable (e.g., low-typicality 'Black' people).

To conclude, although the study of the phenotypicality bias deserves more attention from social psychology and outside the USA, the existing works provide essential elements on the notions of ethnic group typicality and on inter-group attitudes. One element to retain is that the attitudes towards an ethnic group cannot be considered as homogeneous. It is necessary to recognize that among a stigmatized group certain will suffer more discrimination, simply because they will appear be more representative physically of their group. Finally, this could be particularly important in studies considering ethnic groups as homogeneous and to better understand and overcome between- and within-group discrimination.

Chapitre 4 – Within-variability on the Own Group Recognition Bias

Perceived ethnic typicality and the OGRB

In the previous chapter I reviewed the notion of within group variation in the form of perceived ethnic typicality. The question of the homogeneity of ethnic group categories has benefited from a certain amount of research, notably in social psychology. In particular, the existence of an attitudinal bias, called the phenotypicality bias (Maddox, 2004), which relates the greater activation of ethnic prejudices to perceived ethnic typicality, has been highlighted.

These studies point to the existence of physical characteristics perceived as typical of an ethnic category which can affect the way a person is perceived and potentially treated. This work supports the importance of considering these categories as more than homogeneous entities, within which one individual is not so different from another.

This question of within-group variability is particularly important in the context of the OGRB. As stated in the previous chapter, the notion of different ethnic categories is central to OGRB research. However, the vast majority of work in this area focuses on the study of inter-group differences in face recognition, without exploring within-group differences. The group is studied as a universal category, the basis of which seems to be generally based on geographical affiliation. For example, the category 'African' is used to refer to all individuals from that continent, even though it respectively includes some fifty countries and a vast territory. In the same way, the category of 'Whites/Caucasians' seems to be made up of Europeans and their descendants of whom there are numerous groups scattered across the globe (Australian, American, Canadian, etc.), or of all individuals whose skin colour is identified as 'White'. Following this somewhat arbitrary and culturally-dependant categorisation, one might suppose that an Asian or African individual would be able to recognise another Asian or 'African' individual with the same ease, regardless of the country or sometimes even continent of origin of that individual. It is therefore interesting to investigate more precisely whether the OGRB and face recognition abilities as a whole can vary according to this within-group variability.

There are few studies that have looked specifically at this issue. There is, however, a body of literature that has addressed the issue of perceived ethnic variability through studies on ethnic categorisation. In particular, Chen and Hamilton (2011) have proposed a study on multiracial categorisation. In their theoretical framework, they argue that individuals (in the US) tend to categorise others along a relatively dichotomous continuum of ethnic groups

(mainly from 'Black' to 'White'). Other studies also show that Americans are particularly effective and adapted to this so-called 'mono-racial' categorisation (Willadsen-Jensen & IIto, 2006). Chen and Hamilton (2011) found in their results that when faced with individuals whose faces appear "ambiguous", i.e. who do not completely fit into either category, categorisation will be more difficult, slow and costly. This could be explained by the fact that fewer individuals are perceived as ambiguous and that this type of multi-racial categorisation is less developed. This approach to ethnic categorisation raises the question of the limitations of ethnic meta-categories as used in psychological studies. It also leads us to consider the impact that these perceived variations might have on face recognition.

Chiroro et al (2008) have provided some answers to this question. Through a full crossover interaction experiment between the ethnic group of observers and stimulus faces, they demonstrated that the OGRB could vary within these ethnic supra-categories. In their study, 'White' South Africans did show better recognition for 'White' individuals from their own country but not for American 'Whites'. Similarly, 'Black' South Africans also showed recognition expertise for the faces of 'Black' South Africans but not for 'Black' Americans.

Work in this area can be based on the interpretation of Valentine's (1991) multidimensional face model. As outlined in the first theoretical chapter of this thesis, on Valentine's multidimensional model, faces are coded according to their deviation from a norm, a prototype that varies according to each individual's experience. Each dimension of this space refers to the different features used to code faces. Each new face encountered is then coded in this space, relative to the prototype, according to its own characteristics and differences from it. According to this theory, the OGRB can be explained by the fact that own-group faces are encoded on more dimensions and over a much larger spatial distribution than other-group members. Conversely, other-group faces are encoded on fewer dimensions, resulting in a closer cluster of faces in face space. This creates homogeneity in the representations of the different individuals in the other group, making it more difficult to discriminate them.

In this framework, it can be postulated that faces that are perceived as particularly typical of an ethnic other-group will be encoded very close to the norm and thus in a spatially reduced cluster. Therefore an agglomeration of faces will be created around the norm, making face recognition and discrimination more difficult. Conversely, other-group faces that are perceived as particularly atypical of an ethnic group will be encoded further away from the norm. Therefore, they will be encoded further in space from the agglomeration of other-group faces, making their discrimination easier.

Some studies have already verified the theory provided by the Valentine model. For example, O'Toole et al (1994) have shown that perceived ethnic typicality interferes with effective face recognition, specifically in a cross-group context. In their study, the most typical other-group faces were more difficult to recognise than the ethnically atypical ones. More recently, Marsh et al (2021) reported similar results. They found that participants presented higher OGRB between individuals perceived as highly typical ('White vs 'Black') compared to face stimuli perceived as less ethnically typical.

Thus, there is some work in the literature on the impact of perceived ethnic typicality on the OGRB, although this line of research has not received systematic attention. However, the concomitant study of phenotypicality bias and the OGRB has not, to my knowledge, been the subject of specific work. The link between attitudes and perceived ethnic typicality on the one hand and between prejudices and contact on the other hand makes an interesting line of research. Indeed, one can posit that perceived ethnic typicality impacts social contact behaviour, in interaction with prejudices, and that in turn directly impacts own group recognition bias.

Overview

The aim of the present study was to assess how perceived ethnic typicality might impact the OGRB while considering its link to prejudice and contact patterns. To do so, it was necessary, upstream, to create stimulus material, with different levels of perceived ethnic typicality for three groups of interest : 'African', 'European' and 'North-African'. Once this material was developed, I constructed a face recognition task with three different stimulus ethnic groups, where the perceived ethnic typicality was manipulated in order to have faces with two levels of perceived ethnic typicality : high and low.

This experimental work explored the differences in perception of ethnic typicality across three ethnic groups of stimuli, but also assessed how this typicality can impact the OGRB, while also considering prejudice and contact patterns towards the other-group.

Hypothesis

I expected to observe an effect of the ethnic group on face recognition performance with better recognition performance for the own-group (European) faces compared to other-groups (African and North-African) faces. This is the classical OGRB effect.

As proposed in the work of Stelter et al. (2021), I also suggest that the effect of OGRB might be more important when European and African faces are the stimuli than European and North-African faces. This reffers to the existence of more or less proximal (and conversely distal) categories of face. In this framework, North-African faces are considered to be perceived as physically closer to European faces than African towards European.

Second, I expected to observe that the level of perceived ethnic typicality (low or high) has an impact on the OGRB. This recognition bias should be higher for other-group faces for which there is a higher perceived ethnic typicality. In other words, one can expect an interaction effect between ethnic group and perceived ethnic typicality level.

However, I expected prejudice to moderate this effect. Participants with low levels of prejudice should exhibit a reduced effect of the perceived typicality on the OGRB. This should translate into a three-way interaction between group, ethnic typicality level and prejudice.

Finally, optimal contact behaviour (good quality, high quantity contact, with low contact avoidance) with members of the other-group (African or North-African) should also decrease the effect of perceived perceived ethnic typicality on the OGRB. Here again, one can expect a three-way interaction between group, ethnic typicality level and contact pattern.

Pilot study

As demonstrated in the previous chapter, the manipulation of perceived ethnic typicality can be done in several ways. It is possible to create stimuli with variations in phenotypes by using photos of individuals, faces synthesised by software to vary in perceived typicality, face stimuli drawings, or also verbal descriptions, among other possibilities. The manipulation itself can be considered from several angles, whether it is carried out by software or whether it consists of a preliminary establishment of the level of ehtnic typicality by an evaluation of a set of faces. The latter technique has been used on several occasions and, databases like the Chicago Face Database (Ma et al., 2015) include evaluations on various dimensions including perceived ethnic typicality. These evaluations are very practical, particularly as they are based on material validated by a large number of participants. Researchers can then simply use the photos that meet their experimental criteria based on these perceived ethnic typicality scores, which makes it possible to create groups of "high/low typical European" or "high/low typical African" faces.

However, this technique has also certain limitations. Firstly, the ethnic groups available in these databases, which again are predominantly American, are mostly concentrated around

the 'European', 'African' and sometimes 'Asian' groups. The availability of North-African faces remains relatively low or non-existent. Moreover, this observation is not only valid for the databases presenting an evaluation of perceived ethnic typicality but is found for the great majority of the scientific and standardized databases of photos of faces.

Then, a second limitation seems important to discuss. One of the major elements underlying ethnic typicality is its subjective consistency. It is based on a more or less collective representation of who the typical individuals of a category are. As a result, it can be postulated that this representation of perceived ethnic typicality depends on a whole range of elements, including cultural ones. This observation leads me to believe that ethnic typicality deserves to be studied by considering the ingroup perception of these groups typicality within particular study contexts. In my case, this would be the perception that French participants have of ethnic typicality, given that this is who I will use to study the OGRB. To my knowledge, there are no researchers who have developed validated material on perceived ethnic typicality in France.

It therefore appeared necessary to conduct a preliminary study to develop stimuli with different levels of perceived ethnic variation for North-African faces, but also for African and European faces. This development of material was carried out in several steps. First, I developed a categorisation and evaluation task for the faces of our three groups of interest. Then, in a second step, I created from these faces and their typicality scores new synthetic faces whose ethnic typicality I varied on a continuum from not at all typical to completely typical. This last step was carried out using face synthesis software allowing control over perceptual dimensions - the ID software (Tredoux et al., 2006).

Method

Participants

A total of 131 participants completed an online face assessment questionnaire on categorisation and evaluation of ethnic typicality. 43 participants were excluded from the analyses because they either reported seeing a different ethnic group than expected (N= 12) or stopped the task prematurely (N = 31). A total of 88 participants (M_{Age} = 31.05, SD_{Age} = 11.44), of which 56 were female, 28 were male, and 4 were of unidentified gender, were included in the analyses. Participants had to be over 18 years old, be native French speakers

and be European[13]. Participants were recruited online via advertisements on social networks. In a short advertisement, posted on student Facebook groups, it was proposed to participate in a study online and anonymous, lasting approximately 15 minutes on face categorisation.

Material

The study was conducted on Qualtrics (Qualtrics, Provo, UT), an online survey platform, so that the participant could complete the questionnaire from any location and on any medium (computer, tablet and phone), provided that an internet connection was maintained.

Following an analysis of the photos available in standardised photo databases, I found that there were very few photos of North-African individuals available, and in particular of women. Thus, all photos depicted frontal men with neutral emotional expressions aged between 18 and 50 years. This methodological choice regarding the gender of the photos used is addressed in the discussion of this experiment.

In total, 300 photos of African, North-African and European individuals were selected (100 per group). The photos are part of several University photo databases for which scientific use permission has been granted: Radboud Universiteit Nijmegen (The Netherlands), Cape Town University (South Africa), Université Toulouse Jean-Jaurès, University of Utrecht (The Netherlands) and the CaNAFF of the Université Grenoble-Alpes. The photographs are divided into three equal main groups according to the ethnicity declared by the models: North-African, European and African. Those photos did not have the same standardisation parameters, background and size. It was therefore necessary to standardize them. This standardisation was done using Gimp software (Version 2018, 2.10.x). This consisted of aligning the eyes along a 180° axis with identical position in xy space for all the photos, digitally cutting out faces along the outline of the face and the neck, and transposing them onto a neutral grey background, and clothing them in digital white T-shirts.

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[13] The assessment of the ehtnic group was made using the same technique as used in the other experimental study, through the country of birth of grand-parents and a self-reported phototype (see Chapter 2 for details of the procedure)

Table 4.1.

Percentage of ethnic category selection as a function of ethnic group

	African	European	North-African
African	**92.76 %**	0.33%	0.89%
European	0.95 %	**89.32 %**	20.42%
North-African	1.90 %	2.94%	**56.03%**
Other category	3.56 %	4.90%	16.07%
I don't know	1.78 %	2.51%	6.59%

Note. Number in bold refers to the self-reported categorization given by the person was photographed.

Procedure and measures

The participants were informed that the experiment, presented as a study of face categorisation processes, was to last approximately 15 minutes. The participant was then asked to read and sign the consent form.

Of the 300 faces, 30 faces were selected and presented in a completely randomised order to the participant. For each of the faces presented, the participant was asked to categorise the individual into one of several ethnic groups: 'African'; 'European'; 'North-African', 'Other category' or 'I don't know'. The participant was then asked to indicate how typical/representative the face was of the selected ethnic category. The answer was given on a 7-point scale ranging from not at all 'typical/representative' to completely 'typical/representative'.

This was followed by a short demographic questionnaire to collect age, gender, activity and ethnic group. Finally, a debriefing was displayed on the screen, outlining the objectives of the questionnaire and the overall context in which the study was conducted.

Two measures were collected for each face from this pilot study, one of categorisation and one of evaluation of perceived ethnic typicality as a function of the categorisation.

Results and Discussion

Although the main purpose of the data collected was to establish perceived ethnic typicality averages for each face, it is interesting to look at how the different ethnic groups were categorised and evaluated. No hypothesis was made about a potential difference in the assessment of the ethnic category or the perceived ethnic typicality between the groups, but

Table 4.2.

Evaluation of perceived ethnic typicality for stimuli categorised the same as that declared for the original photograph

	African	European	North-African
Very Typical / representative	22.99 %	17.3%	9.98%
Typical/ representative	30.78%	27.98%	21.76%
Somewhat typical/ representative	27.97%	26.38%	37.33%
Neither typical nor atypical	11.53%	18.90%	18.96%
Somewhat atypical/not representative	3.96%	5.03%	7.98%
Atypical/not representative	1.28%	2.58%	2.99%
Very atypical/not representative	0.26%	1.35%	0.39%
I don't know	0.77%	0.49%	0.60%

Note. When the participant did not correctly categorise the stimulus, I automatically associated the rating phenotypicality to be 'Very atypical/ not representative'. However, one should note that those ratings are not present in Table 4.2, since it only reports data for correctly categorised stimuli.

large differences are visible. For example, a first distinction can be made on the categorisation data according to ethnic group (Table 4.1).

It appears that the North-African stimuli were more difficult to correctly categorise for participants than the African and European stimuli. Indeed, in only 56.03% of cases did participants correctly identify the North-African ethnic group, compared to 92.76% for the African stimuli and 89.32% for the European stimuli. In 20% of the cases, the North-African faces were identified as European and in just over 15% as belonging to another category. Implication for such differences in categorisation are addressed in the discussion.

A second point of interest concerns the way in which the ethnic typicality of the correctly identified stimulus was assessed (Table 4.2). Typicality scores were calculated by averaging all the ratings given for each face individually. However, in the case where the categorisation was not accurate (e.g., the participant determines that the individual belongs to the European category while the stimulus represents an African individual), I automatically assigned the lowest possible typicality rating, regardless of the participant's assessment. Indeed, if the participant did not consider the individual in question to belong to the expected group, I considered that it could only be perceived as atypical of its real group of belonging.

All three ethnic groups had generally high ethnic typicality ratings with very few evaluations around 'Atypical' or 'Very atypical'. It is possible that when the participant felt that the person was not at all typical of a particular group, he/she preferred to categorise that individual into another ethnic group. But here again, North-African faces seem to have been assessed in terms of perceived ethnic typicality slightly differently from the other two groups. For both Europeans and Africans, between 45% and 52% of the ratings are in the high typicality range ("Very typical/representative" and "Typical/representative"). Conversely, for North-African faces, there is a greater concentration of ratings around the median ehtnic typicality values (55%) for the ratings "Quite typical/representative" and "Neither typical nor typical". It is possible that our participants had more difficulty identifying faces as strongly typical for the North-African group compared to the African and European stimuli. It is difficult to theorise about these ratings but these data may be useful in interpreting the results obtained in the final study.

These data were used to develop the photographic material in the final experiment of this thesis. Beyond this validation, it appears that differences in the perception of ethnic typicality exist between the groups. It may be interesting in future research to further explore this difference in the perception of ethnic typicality between the groups.

Experimental study

Method

Participants

A total of 237[14] participants were recruited for this study. 66 of them had to be excluded because they reported not being European (N = 4) or because they didn't complete the experiment (N = 62). 171 participants were retained for the analysis. The final sample was composed of 156 women and 31 men, 148 students and 44 non-students (M_{Age} = 31.78, SD_{Age} = 13.00). 89 participants were recruited in the experimental condition North-African versus

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[14] The different pre-tests to validate the photo material gathered a total of 119 participants, the details of which are given in the material section. Those participants are not included in the final sample number provided here.

Figure 4.1

Example of the generation of a set of North-African faces using a setting of high perceived ethnic typicality setting on the ID software
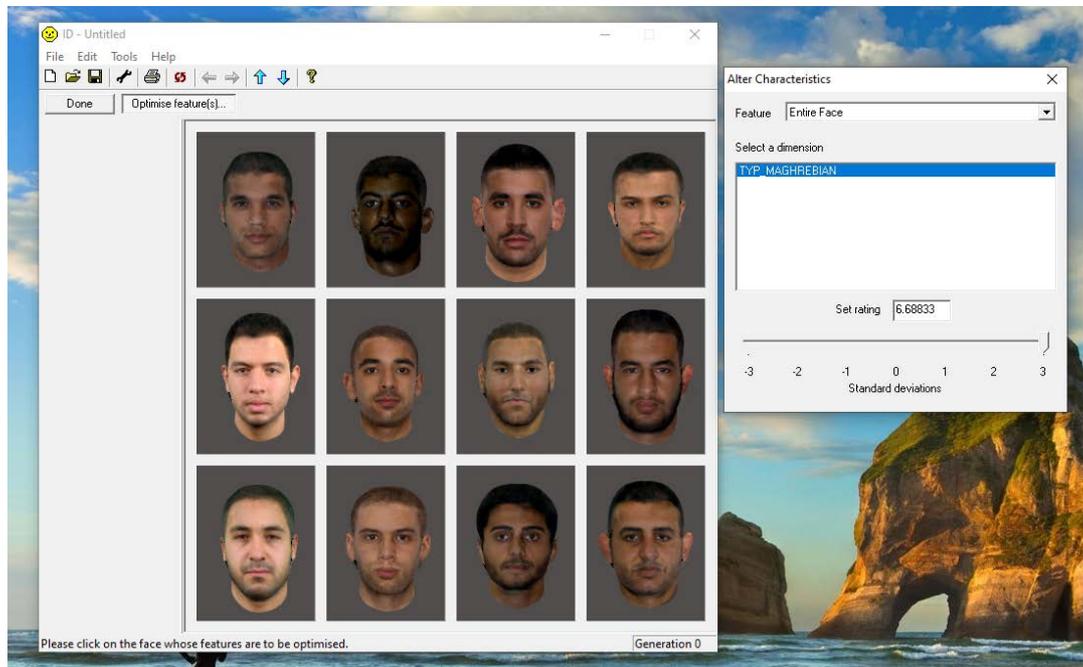
Note. The window on the left is the main window were faces appear, and where all parameters are accessible. The dialog box on the right allows alteration of characteristics of faces, i.e., the perceived ethnic typicality. In this case, it was possible to change from -3 (low typicality) to 3 (high typicality).

European and 82 in the group African versus European. All participants were over 18 years of age, were considered as European[15] and were native French speakers.

Material

The study was entirely conducted on the Qualtrics online platform (Qualtrics, Provo, UT) in the own device of the participant from any location as long as a an internet connexion was maintained.

Creation of stimuli faces

The photo material was created using ID software (ID; Tredoux et al., 2006). In order to integrate the faces evaluated in the pilot study into the software, it was necessary to meticulously map different areas on each face that are essential for the generation of new faces with the software. Indeed, the ID software allows the integration of the dimensional ratings into

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[15] As for the pilot study, the method used to assess the ethnic group of participant is exposed in Chapter 2.

a face model, subsequently generating faces that can vary in the desired dimensional ratings. However, in order to do this, a preliminary step of mapping the different features and areas of the face had to be implemented on Photoshop (version 2022, 23.x). This consisted of creating tracings on each face, the contours of which were to delimit precise zones and angles of the faces, namely: the eyes with a distinction between the eyelids and pupils, the nose, the nostrils, the contours of the mouth, the philtrum, the general contour of the face, the ears, the neck and the hairline. It was possible to use a template whose contours had to be adapted to each face. Particular attention was paid to ensure that the various contours did not overlap in order to allow for optimal vector-based extraction of face textures.

It was also necessary to modify the background colours for each ethnic group. After several trials, it became apparent that a single neutral grey background was not the most suitable as it did not highlight the colorimetry of the different skin tones. Therefore, three different levels of grey were chosen, ranging from the darkest for the European faces to the lightest for the African faces. These changes were also made using Photoshop for each of the 300 faces used in the pilot study.

Once the original photos had been modified, they could be implemented in the ID Program with a perceived ethnic typicality score of 1 to 7 obtained during the pilot study. From the software, it was possible to create an unlimited number of faces by varying the perceived ethnic typicality from 'Strongly atypical' to 'Strongly typical' (see an example in Figure 4.1).

The selection of the faces was done in several steps that had to be repeated twice to adjust the stimuli appropriately. First, 50 faces were generated per group (25 per typicality level). These faces were then modified (see an example on Figure 4.2), again on Photoshop, to correct the irregularities produced by the software (e.g., blurred areas of hair, discoloration of the skin). This step was sometimes essential to make the faces generated believable as real human faces. Each face was then evaluated by 10 participants to ensure satisfactory handling of the perceived ethnic typicality levels.

Figure 4.2.

Example of the modification done on Photoshop on an European faces generated with the ID software.

A   B
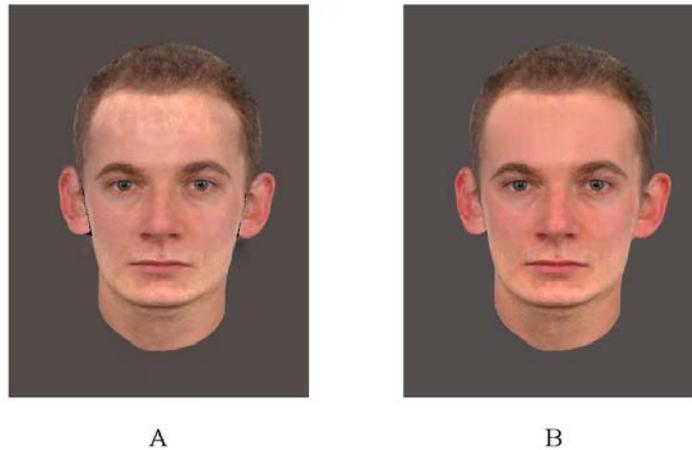
Note. This face was generated with the ID program. The stimulus on the left (A) is the original photo created by the software. The stimulus on the left (B) is the same photo with alteration made on Photoshop in order to decrease the blurring area on the forehead and the black line around the ears.

From these assessments, 28 faces per group were selected from those with either the highest ethnic typicality scores (High Typicality) or the lowest scores (Low Typicality). A pre-test was then run on Qualtrics to check that a recognition task using these faces encoded during 5 seconds was neither too easy nor too difficult. The scores obtained from 55 participants showed very low discrimination threshold scores for all face types (d' <0.5). These results indicated that the faces presented were too similar to each other to be adequately distinguished in a classical recognition task. This was true for all types of faces, regardless of their group and typicality level.

I therefore decided to repeat the same process of creating, validating and testing the stimulus faces by setting two parameters in the ID software that relaxed the constraints on the model coefficients so as to produce faces that were less alike. All the steps mentioned above from face generation were therefore repeated. 50 new faces were created for each ethnic group and were sometimes modified on Photoshop to ensure sufficient credibility. 10 new participants assessed the perceived ethnic typicality of each face and from these results 28 faces per group were

Figure 4.3.

Illustration of High perceived Typicality (HT) and Low perceived Typicality faces (LT)
generated with the ID software and retain for the final experiment
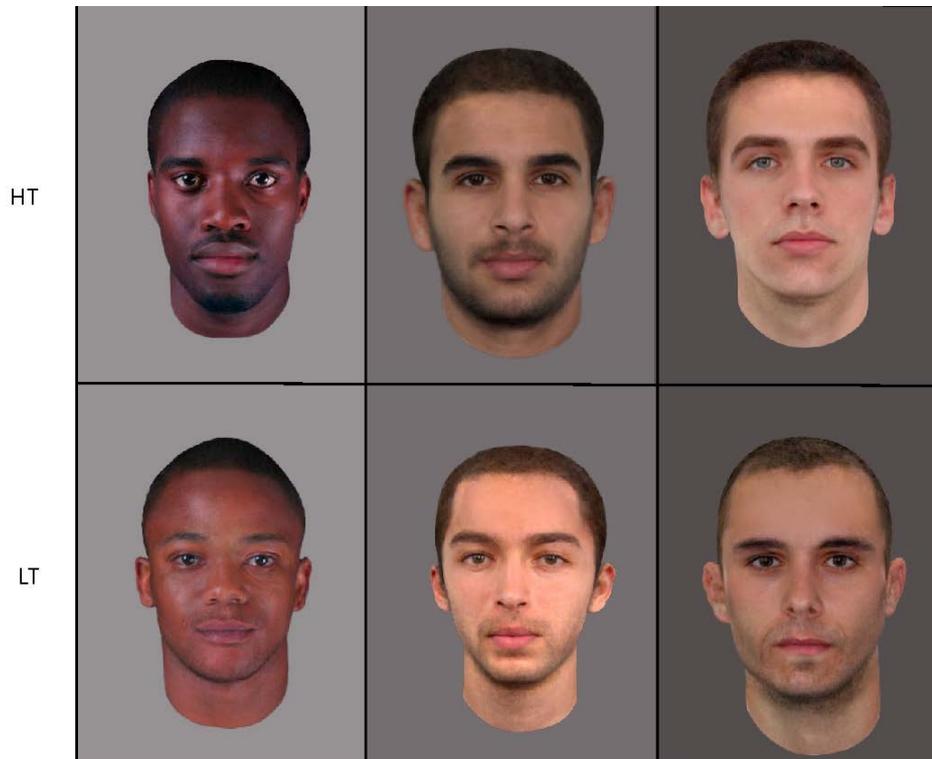
Note. Those faces were generated with the ID software.
From left to right, African, North-African and European stimuli. Different greyscales background were used
as for different ethnic groups in order to not respect the different colorimetry of skin tone.

selected. In order to ensure that these new faces were satisfactory enough to allow a recognition task that was not too difficult, 44 new participants performed a recognition task on Qualtrics on these new faces. The same exposure time (5 seconds) for encoding of the face stimuli was used. The dprime scores were more satisfactory but still relatively low ($0.5 < d' < 1$), here again for all type of face group and typicality level. I therefore decided to modify the exposure time and to use a longer encoding (from 5 seconds to 7 seconds per face) in order to adjust the simplicity of the task.

In the final set of materials, 84 photos in 406x541 format were used for this experiment (see an example in Figure 4.3): 28 of each ethnic group (which included 14 high typicality and 14 low typicality in each group). All generated faces were of male faces with a neutral expression. A transformation which consisted of transforming the faces to greyscale was carried out for the stimuli used in the recognition phase so that the task was one of face recognition and not merely picture or image recognition.

I also assessed prejudice towards each target group, and self-reported contact (quantity, quality, avoidance) for each participant. The Prejudice and Contact scales were those constructed and tested during the first part of the thesis.

Measures

Recognition performance for own and other-group faces was measured with an old-new recognition test (yielding hit rate, false alarm rate, and the signal detection measures *d'* and *c*, Stanislaw & Todorov, 1999).

Contact patterns were measured with a self reported questionnaire through three main dimensions : quantity, quality and avoidance of interaction with other-group members. Similarly, ethnic prejudice was measured using a self-reported questionnaire. Both questionnaires are from the tested material reported in the first part of this PhD. Although they were created to measure contact patterns and prejudice towards North-African individuals, they were also adapted to measure Prejudice and Contact with the African population as the target (Appendix L).

Procedure

A flow diagram of the procedure is shown in Figure 4.4 in order to facilitate comprehension of the experimental design.

Participants were recruited in two ways: either through the UT2J[16] credit bonus points system or through social networks. All participants were informed that the experiment, presented as a face perception study, lasted approximately 30 minutes. As the study was entirely computer-based, the participant was able to complete the experiment from any location as long as the internet was available. The participant was asked to participate on a computer in a quiet, isolated area to avoid being disturbed during the task.

Once the participant had clicked on the link, they could read the consent form. Once consent has been given, the first instruction was displayed on the screen. The participant was informed that a series of faces would be presented on the screen and that they would scroll through automatically. The participant was then randomly assigned by the software to one of the two experimental groups.

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[16] The bonus point system allows students to obtain a bonus of +0.5 points on a methodology course in exchange for participation in a psychology study carried out on campus. This process is not compulsory.

28 faces were presented in random order: 14 from the own-group (European) and 14 from one of the other groups (African or North-African). Within each of these ethnic group conditions, 2 different levels of perceived ethnic typicality were presented: low and high (seven faces per level). Each face was displayed for seven seconds on the screen.

Once the 28 faces had been seen, a 5-minute distracter task was completed, saturating working memory and increasing the difficulty of the face recognition task. It consisted of answering questions of different types, such as mental arithmetic, general knowledge questions, riddles etc.

After this distracter task, a new instruction appeared on the screen. The participant was informed that a new set of faces was going to appear and that for each face they had to determine whether they had already seen that face in the first phase. To do so, they ticked the corresponding "yes" or "no" answer. They were also informed that there was no time limit, but that once the answer was validated, it was not possible to go back. This phase corresponds to the recognition phase where the 28 previously encoded faces are presented with 28 new faces: 14 from the own-group and 14 from the other-group (seven of each perceived ethnic typicality level).

Once the recognition task was completed, the participant was informed that an ethnic typicality assessment task would be presented. Five faces from any group (African, European and North-African) were randomly presented on the screen. The participant was asked to indicate how typical/representative they felt the face was of the ethnic group to which the stimulus belonged. The answer was given on a 7-point Likert scale ranging from "Strongly atypical/ unrepresentative" to "Strongly typical/ representative".

Then, the last phase consisted of the completion of the two questionnaires developed for people of North-African origin in the first part of this thesis on prejudices on the one hand and social interaction patterns on the other. Finally, a short demographic questionnaire was presented in order to collect the age, gender and ethnic group to which they belonged, using the same process used in the other experimental procedure of this PhD (continent of birth of grand-parents, and self-reported phototype, cf. Chapter 2).

At the end of the experiment, a written debriefing was delivered, to explain the different objectives of the study.

Figure 4.4

Flow chart of the procedure of the experimental study on perceived ethnic typicality and OGRB
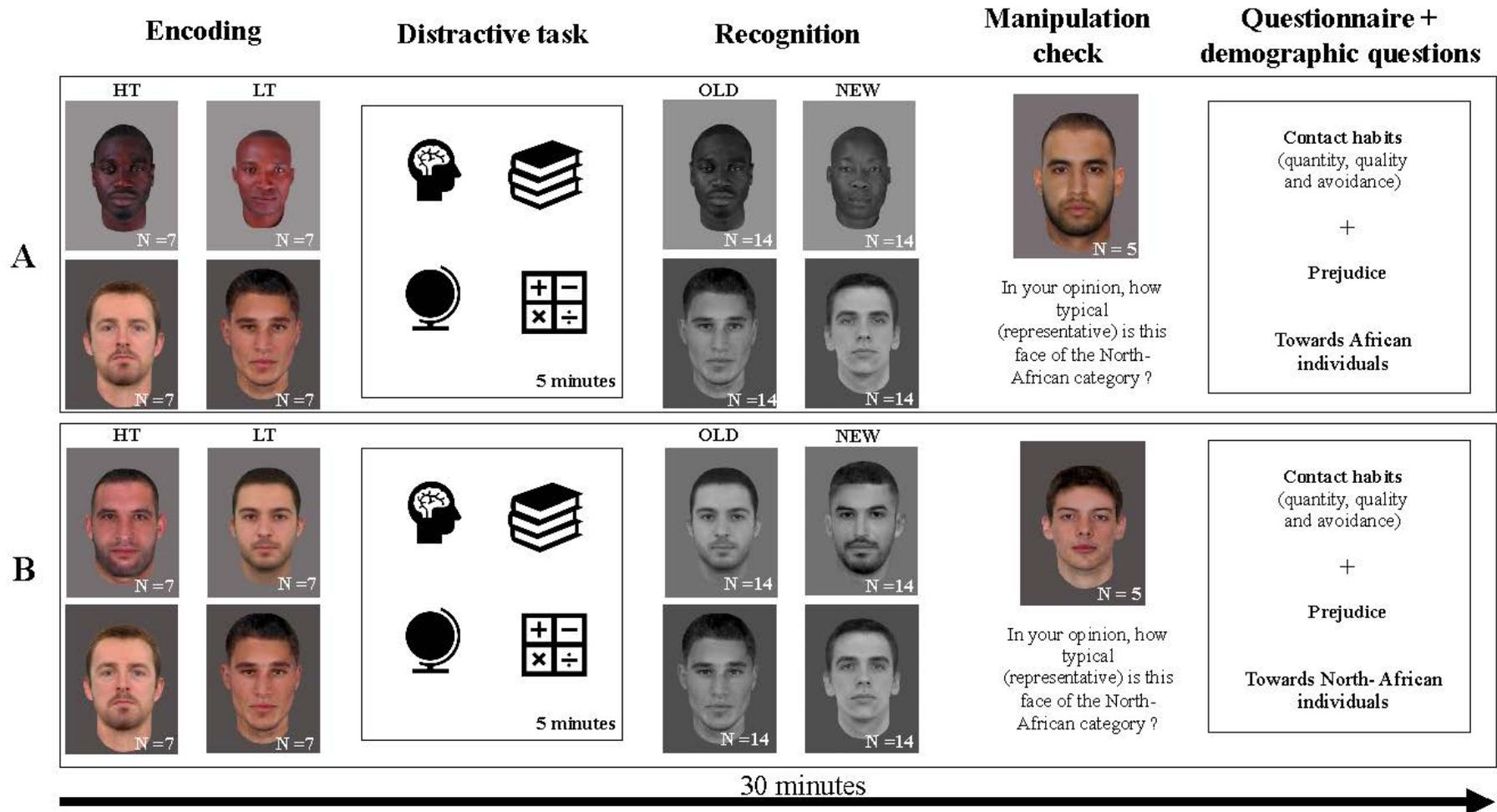
Note. The faces presented in this diagram were generated with the ID Program

Participants were divided into the experimental group A) African versus European or B) North-African versus European.

Table 4.3

Mean and standard deviations of the evaluation of perceived ethnic typicality accross ethnic and typicality groups

Stimulus group	Typicality	*M*	*SD*
African	High Typicality	5.91	0.52
	Low Typicality	5.26	0.45
European	High Typicality	5.87	0.38
	Low Typicality	4.97	0.41
North-African	High Typicality	5.33	0.55
	Low Typicality	3.96	0.81

Note. The difference between stimuli faces from all ethnic group significantly differed from the High and Low Typicality conditions

Results

Manipulation check

I verified that the different stimulus faces used in this experiment were indeed perceived by the participants as either 'Very typical' or 'Very atypical' of the three ethnic categories (African, European and North-African). To do this, t-tests between the ratings given to different perceived ethnic typicality groups for each ethnic group were performed. Significant differences were found in the mean evaluation of African faces $t(26) = 3.53$, $p<.01$, $d = 1.38$, European faces $t(26) = 6.02$, $p<.01$, $d = 2.36$, and for North-African faces $t(26) = 5.20$, $p<.001$, $d = 2.04$. For each ethnic group, the High Typicality faces were effectively rated as having greater ethnic typicality than the faces generated in Low Typicality (Table 4.3). In other words, the manipulation of perceived ethnic typicality into two levels was successful for each group.

Table 4.4.

Means, standard deviations, and correlations for the three scale variables as a function of the experimental condition

Variable	*Experimental Condition*	M	SD	1	2
1. Contact	Afr/Eur	43.65	7.06		
	Nafr/Eur	43.43	7.76		
2. Avoidance	Afr/Eur	17.35	6.08	-.43** [-.59, -.23]	
	Nafr/Eur	21.04	8.07	-.28** [-.46, -.07]	
3. Prejudice	Afr/Eur	47.07	9.02	-.52** [-.67, -.35]	.59** [.43, .71]
	Nafr/Eur	49.15	11.60	-.54** [-.67, -.37]	.52** [.35, .66]

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). *: $p < .05$; **: $p < .01$.

Prejudice and contact

The scores of the 2 scales on contact and prejudice patterns were established to account for 2 dimensions for contact, namely contact avoidance and contact (quantity and quality) and a general prejudice score. Table 4.4 shows the correlations between the scores on the prejudice and contact scales. As expected, the prejudice score is negatively correlated with the contact score and positively correlated with the contact avoidance score. Similarly, the contact avoidance score is negatively correlated with the contact score.

Face recognition response

As in the analysis conducted on my first experimental procedure, the modelling of the recognition data involved multiple variables. My hypotheses also included multiple interactions. In order to account for this complex design, I conducted two analyses for both of my SDT (Signal Detection Theory) measure, namely the discrimination abilities (*d'*) and response criterion (*c*).

In a first analysis, I modelled my discrimination data (d') using a generalized mixed linear model with the variables manipulated in the experimental design. That is the d' score was modelled as a function of ethnicity of the target group (African, European and North-African), along with the perceived ethnic typicality levels (high versus low) and experimental group (African and European stimuli vs North-African and European stimuli), as fixed effects (predictors), and participant identity as a random effect. The Anova table for this model is shown in Table 4.5.

Two main effects and two interactions were evident and are represented in Figure 4.5. First, a main effect of the stimulus group presented across both exprimental conditions, the European faces being better recognized than North-African and African faces combined. But it is the interaction with the experimental group that allows one to confirm that an OGRB is present in both experimental groups. European participants presented better face recognition for European faces compared to African faces (M_{Eur} = 1.04, SD_{Eur} = 0.82 vs M_{Afr}= 0.88, SD_{Afr} = 0.79, p <.05, t = 2.17, d = 0.20 and compared to North-African faces (M_{Eur} = 1.28, SD_{Eur}= 0.83 vs M_{NAfr}= 0.91, SD_{NAfr} = 0.94, p <.001, t = 5.25, d = 0.42).

Then, there was a main effect of the perceived ethnic typicality. Stimuli faces of higher typicality were recognized better than the low typicality ones, across all stimulus group and experimental conditions (M_{HT} = 1.12, SD_{HT}= 0.83 vs M_{LT}= 0.94, SD_{LT} = 0.89, p<.001, t = 3.51, d = 0.21). Finally, the perceived ethnic typicality and the stimulus group interacted on d'. Across the two experimental condition, one can observe a significant difference between low typicality faces, where European faces were better recognized than African and North-African faces (M_{Eur} = 1.15, SD_{Eur}= 0.85 vs M_{Other}= 0.73, SD_{Other} = 0.88, p<.001, t = 5.73, d = 0.49). More surprisingly, this difference is not significant for the high typicality group. In other words, the OGRB is not replicated when faces are perceived as highly typical of their ethnic group.

Applying the same logic, I modelled the criterion of response (c) using a generalized mixed linear model, with ethnicity of the target group (African, European and North-African), along with the perceived ethnic typicality levels (high versus low) and experimental group (African and European stimuli vs North-African and European stimuli), as fixed effects and participant identity as random effect. As for the d' I found a main effect of the stimulus group on c (χ^2 (1) = 23.73, p < .001). Participants presented higher response criterion, so a more conservative type of response (response tendency to the "no") for the European faces than North-African and African faces (M_{Eur} = 0.50, SD_{Eur} = 0.62 vs M_{Other}= 0.13, SD_{Other} = 0.53, p

Table 4.5

Anova table of data modelling of d' for African and European stimuli

	$\chi^2(1)$	*p* values
Stimulus group	28.01	<.001 ***
Experimental group	2.21	.14
Ethnic Typicality	12.57	<.001 ***
Stimulus group x Experimental group	4.28	0.04 *
Stimulus group x Ethnic Typicality	8.51	<.01 **
Experimental group x Ethnic Typicality	0.45	.50
Stimulus group x Experimental group x Ethnic Typicality	0.08	.78

Figure 4.5

Mean of d' as a function of experimental group, group of stimulus and perceived ethnic typicality
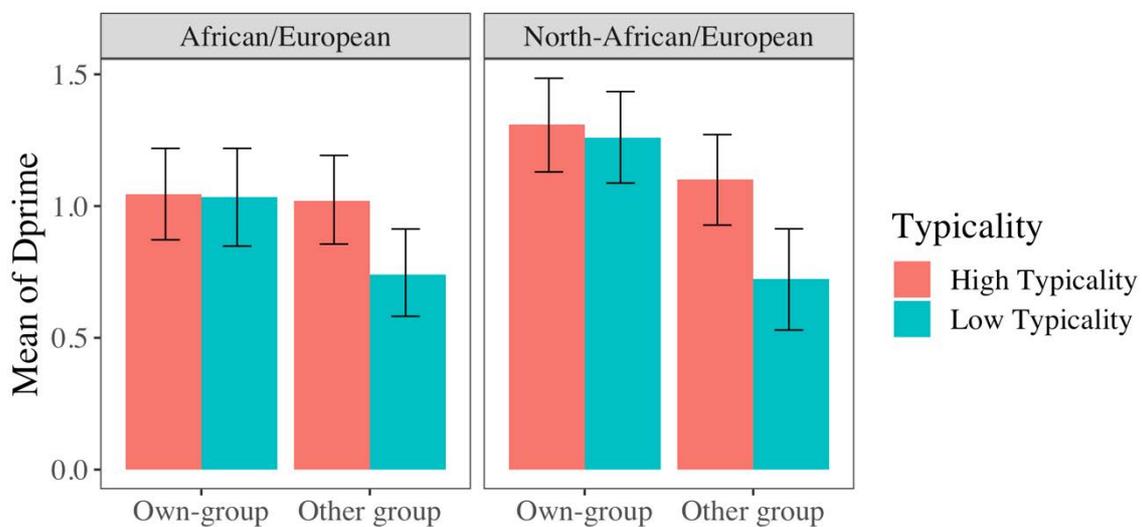
Note. Error bars are 95% bootstrap confidence intervals.

The left figure presents the *d'* score in the experimental group where African and European stimuli were presented, the right figure presents the group where North-African and European stimuli were presented. Groups of stimuli and perceived ethnic typicality both significantly impacted the discrimination ability.

< .001, t= 4.91, d = 0.26). I also find a main effect of perceived ethnic typicality on c (χ^2 (1) = 10.63, p < .01) and a two way interaction between perceived ethnic typicality and the ethnic group of stimulus (χ^2 (1) = 7.20, p < .01). Post-hoc analysis informs us that there is a difference between high typical and low typical faces but for other faces only (so North-African and African faces). Faces perceived as low in ethnic typicality beneficited from a more conservative response criterion than faces perceived as high in ethnic typicality (M_{LT} = 0.21, SD_{LT} = 0.51 vs M_{HT}= 0.05, SD_{HT} = 0.54, p < .001, t= 4.17, d = 0.31).

In a second analysis, I modelled the data in the same way as previously but integrating the social variables in, namely social contact (quantity and quality), avoidance of interaction, and prejudice, as fixed effects, still with the participant identity as a random effect.

This model included all the interactions expected in the hypotheses. As for the previous model, one can note a main effect of the stimulus group on d' (χ^2 (1) = 27.65, p< .001), but also of ethnic typicality (χ^2 (1) = 12.41, p < .001). Then, the two-way interaction of the stimulus group and ethnic typicality was reproduced (χ^2 (1) = 8.40, p< .01). However, the interaction effect between the stimulus group and the experimental group did not reach significance (χ^2 (1) = 2.96, p = .08). This makes it difficult to assert that there was an OGRB on both experimental groups. Indeed, the main effect of stimulus group still presents across experimental condition, European faces being better recognized than African and North-African combined, but taking the experimental conditions individually the differences between stimulus groups was not significant, although close to being so.

No other effects including the social variables were evident in this analysis. In other words, social contact, avoidance and prejudice did not interact with the perceived ethnic typicality, stimulus group and experimental group on the discrimination ability.

The model on the response criterion (c) using the same structure as the one used for the second modelisation of d', presented a structure of effects similar as the first modelisation. One can note a main effect of the stimulus group (χ^2 (1) = 23.56, p < .001), the perceived ethnic typicality (χ^2 (1) = 10.51, p < .01) and an intercation between those two variables on c (χ^2 (1) = 7.12, p < .01).

Discussion

The results of this experiment provide several insights. First, an OGRB was replicated in both experimental groups, but only in the first modelling of the data which did not include the social variables. In the second modelling of the data, I observed a generally better recognition of own-group faces compared to other group faces but no interaction effect with the experimental group. This first element partially confirm the hypothesis on the replication of OGRB for both of our groups : North-African and African. Moreover, the discrimination threshold (d') value and the effect size ($d_{Afr}= 0.20$ and $d_{Nafr}= 0.42$) were both low and will be addressed later on.

Then, the experimental manipulation, i.e., ethnic typicality variation of faces, was shown to interact with the stimulus group, but across both stimulus groups. Highly ethnically typical faces were better recognised than faces with low ethnic typicality. This does partially support my hypothesis of an interaction effect of the group and ethnic typicality. Although a two-way interaction effect including perceived ethnic typicality was identified, it presented, surprisingly, an inverse pattern to the one expected, with better face recognition performance for high typicality faces of all stimulus ethnic groups compared to low typicality stimuli.

Finally, the relationships between measures of prejudice, avoidance and contact patterns seem to be consistent with our expectations and the literature in both experimental groups. However, these different variables did not show any impact on discrimination ability when studied in interaction with the perceived ethnic typicality and ethnic group of stimuli. Those results infirm the last hypothesis predicting an interaction effect between the stimulus group, perceived ethnic typicality and the three social variables.

The study under discussion presented many challenges. First of all, the creation and validation of the photo material proved to be complex and time consuming. Taking into account the importance of considering ethnic groups as socially constructed, it appeared necessary to construct and validate photo material to the French population and to the ethnic stimulus groups studied.

Difficulties arose at several stages of my pilot and pre-test study. The choice of the photos I used as a basis, for example, has certain limitations. Firstly, I encountered a major difficulty in the availability of clearly categorised photographs of North-African people. In particular, I encountered categorisations such as 'Oriental' or 'Arabic' that did not seem to correspond to my initial criteria. Indeed, my aim was to study the OGRB on a North-African population of stimuli, as I did in my first experiment, which includes individuals from the

Maghreb. This particular population has a specific importance in the French ethnic context due to the large diaspora of North-Africans present in France. However, databases offering photographs of individuals from this particular group are relatively rare. This resulted in a mixture of photos from different databases. For this kind of task, the use of a large number of databases would be recommended (Sergent, 1986). However, the use of a multitude of sources does not facilitate the standardisation of the different photos.

This also implied that I should select databases where the upstream modifications were quite important in order to correct, for example, reflections or uneven luminosity. These difficulties were not found for African and European faces for which larger resources are available.

Second, the near absence of North-African women's material in scientific databases did not allow me to include women's faces in my study. This limitation could be important, especially when one considers that the OGRB is also concerned with gender groups (Lovén et al., 2011) and that the study of phenotypicality bias has also been singled out as presenting predominantly male stimuli-based work, ignoring potential gender-related effects.

This limitation of the number of photos of North-African individuals available also constrained me to use 100 photos for this group, and thus for the other groups studied. However, it appeared during the generation of the synthetic faces with the ID software that a greater number of faces would have made it possible to greatly improve the quality of the material thus created.

Finally, the face generation stage also proved to be more challenging than anticipated. The synthetic African faces were of very good quality compared to the European and North-African faces, specifically for the high perceived ethnic typicality stimuli. The large variability in scalp and facial hair (e.g., beard/moustache) in the photos used for the European and North-African faces caused significant alterations in these areas (e.g., discoloration, "ghost hair" etc.). These issues resulted in a lower overall quality of synthetic faces for these stimulus groups and perhaps to a decline in the credibility of these faces as "real" faces. In particular, North-African faces basis used to generate the synthetic faces from the ID software, were drawn from a larger number of databases than the other ethnic groups. As a result, the photographic standardisation between photos was sometimes very different, with significant differences in colour and brightness. The photos generated by the ID software were therefore of very uneven quality. It was often necessary to correct them afterwards to improve the overall quality. This could have been reflected in the results of the typicality assessment of North African faces. Referring to Table 4.3 presenting these evaluations of the perceived ethnic typicality, it can be noted that

North African generated faces received lower evaluations for both very typical and low typical faces than the other two ethnic groups. This may reflect the fact that the lower quality North African faces were judged to be less credible and therefore more distinctive and atypical than the European and African faces. As a result, they may have lower perceived ethnic typicality scores.

Regarding the results of this study and the non-validation of some of the hypotheses, several points can be made. First of all, it is important to note that face discrimination abilities, regardless of the stimulus group, were relatively low. This could be explained by the fact that the protocol was online and that the participants may not always have benefited from an adequate environment and support for participation. It should be noted, however, that it was still possible to replicate an OGRB, between African and European faces on the one hand and European and North-African faces on the other, again demonstrating the robustness of the OGRB.

Concerning the hypothesis on the effects of perceived ethnic typicality, one can note an unexpected result. Although an interaction effect of the ethnic typicality levels on face recognition was demonstrated, the direction of the results was surprising. Indeed, all stimulus group faces with high ethnic typicality were better recognised than the low typicality faces. These results do not corroborate my hypotheses and do not support the explanation provided by the multidimensional model of faces developed by Valentine (1991) and previous research (e.g., Marsh et al., 2021; O'Toole et al., 1994).

It is possible that the faces generated for the North-African group were affected in their assessment of ethnic typicality by the issues around 'real-face' credibility mentioned above. This may have resulted in an assessment as 'very atypical' on the basis of the stimulus not being credible as a real face rather than a true assessment of ethnic atypicality. Thus, it is possible that the typicality effect observed in this study, which did not support my initial expectations, is an artefact of the stimulus material. Post-hoc assessment of the perceived reality of the stimuli could establish whether the results obtained were affected by the nature of the stimuli used, but was not attempted in this study.

This surprising effect of perceived ethnic typicality was found across both experimental conditions. However, it is not possible to know whether these results are found equivalently in the two experimental groups. From Figure 4.5 it appears, however, that the variation in ethnic typicality seems to have particularly impacted on the other-group (African and North African) faces compared to the own-group (European) faces. A final explanation I can offer for this surprising effect of typicality across the two ethnic groups lies in the fact that it is possible that

the low ethnic typicality faces were perceived as ambiguous. This type of face makes ethnic categorisation more difficult (Chen & Hamilton, 2011). It can be postulated that this disruption in the ethnic categorisation process significantly impacted face recognition for these particular stimuli. One would therefore be dealing with a disruptive effect of ethnic categorisation rather than perceived ethnic typicality.

Then, concerning the lack of verification of my hypotheses about interaction effects between group, typicality and contact/prejudice patterns, it is possible here again to point out a problem in the general conception of perceived ethnic typicality that didn't allow me to observe the expected effect. Or, as was raised in the discussion of the first experiment, a student population with little variability in contact behaviour and prejudices makes it less likely to observe the impact of such variables on face recognition. It is also possible that contact patterns and ethnic prejudice are not a sufficiently important part of the OGRB effect, and that the statistical power of the sample size of this experiment was not sufficient to show significant interaction effects. However, one can note that the different elements underlying contact (quantity, quality on the one hand and avoidance on the other) and ethnic prejudice, for both the African and North-African groups, show significant correlations between each other, confirming what we know from other literature. This seems to at least confirm that the dimensions measured with the two scales correspond to constructs that are classically reported in the literature.

This study did not validate all of the hypotheses postulated above. Although it was possible to reproduce OGRBs with two types of stimuli, and a perceived ethnic typicality effect was shown, it appears that the latter does not confirm the results presented in the literature. Once again, there was no effect of contact patterns and prejudice on the OGRB, or an interaction between these variables with typicality.

Although these results may seem disappointing they do highlight a number of points. Firstly, if one consider that the ethnic typicality manipulation implemented worked well, it would seem that it significantly impacted recognition performance, even if it happened in an unexpected way. This confirms the need to consider ethnic groups beyond a homogeneous whole and to systematically consider within-group variability in OGRB studies.

Secondly, this study has highlighted the complexity of conceptualising, and thus manipulating perceived ethnic typicality. The way I have handled and approached the concept of ethnic typicality is only one of a number of possible ways. Future research could propose more protocols using Artificial Intelligence, which already offers very good, fast and qualitative alternatives for face creation. The IA 'Stability Diffusion' (Stability.AI, Rombach

et al., 2022) for example, offers the possibility to generate unlimited numbers of photos by using a short text description. In the case of the creation of photos of faces of varying perceived ethnic typicality, it would be possible, after the collection of qualitative data, to establish typical descriptions of individuals from different groups and perceived ethnic typicality in order to create from those elements, photos of individuals corresponding to the researcher's expectations.

General Discussion

Objectives of the PhD

In this thesis project, I approached the OGRB from two main angles. First, I tested the impact of social dimensions, which have been highlighted in the literature as important for understanding this bias, on face recognition abilities. In a second part, I suggested a potential link between the OGRB and another attitudinal bias, the phenotypicality bias, which I tested by manipulating perceived ethnic typicality. The aim of this thesis was not to offer an explanation of the origins of the bias or to address a comprehensive model of its components. Rather, it was to reposition the study of the OGRB, which has important cognitive underpinnings, in a social context. In doing so, I wanted to test a number of hypotheses about how social, but also cognitive, variables interact and influence face recognition abilities.

An important part of my work has been a set of in-depth experimental studies of social interactions in relation to face recognition, being mindful of the significance of ecological context. This has led to the consideration of different sub-components of contact such as its quantity and quality valence, but also to the consideration of elements that are little studies in the OGRB literature such as interaction avoidance behaviour and intergroup anxiety. To further anchor my studies socially, I included a measure of prejudice, the importance of which in relation to social contact is no longer in question (see Pettigrew & Tropp, 2006, for a review).

Another part of my work has been to challenge the notion of 'ethnic' or 'race' group in OGRB studies. This has led me to explore within-group variability and its impact on prejudice and face recognition. My objective was not to provide a framed, universal and defined conceptualisation of what an ethnic group is, and I don't think that is possible or defensible. Rather, it was to understand what effect the perception of ethnic group membership has, on both social and memory processes. An underlying objective was to highlight the existence of within-group heterogeneity and to measure its consequences for the OGRB. Again, the aim was to understand what may appear to be a cognitive process, such as the perception of physical characteristics (skin colour, haircut, etc.), in its social context and to understand how these dimensions interact.

Summary of the main results

In two experiments, I was able to replicate the existence of the OGRB on a Franco-European population vis-à-vis people of North-African and African origin, although the effect sizes were relatively small.

In the first experiment, I could not find a clear pattern of effect of social contact, either manipulated or measured in terms of participants' personal histories, on recognition performance. It was therefore not possible to confirm the hypothesis that OGRB is a function of social interaction patterns. Similarly, the ethnic prejudice and interaction anxiety variables were not assessed as having a significant impact on recognition performance in interaction with social contact. Thus, the hypotheses regarding the impact of social components on OGRB could not be validated. In the same experiment, I investigated potential differences in the visual strategies employed during face encoding and recognition. I tested whether such differences could be found across ethnic groups of stimuli and as a function of social contact, whether again manipulated or measured in terms of individual history. The first hypothesis, i.e., concerning differences across ethnicities, could not be confirmed. The European participants did not use different visual scanning for North-African and European stimulus groups. However, it was possible to show the effects of social contact, measured and manipulated, on visual strategies. In particular, it was shown that the different social contact modes studied (quantity, quality and avoidance) have a significant impact on how a face is visually scanned. Interpretation of these results should be made with caution as these effects were found to be independent of the ethnic group of the stimuli. A high level of self-reported contact with North-African individuals was associated with greater visual concentration on the upper face. Conversely, contact avoidance behaviours were associated with lower concentration on the lower face. Then, an impact of the contact manipulation was also found, as stimuli perceived with contact were processed differently, visually. More specifically, face stimuli encoded during social interaction gathered fewer fixations compared to stimuli encoded without social interaction.

I then conducted a systematic review on the topic of phenotypicality bias, and more specifically on the impact of perceived ethnicity on the activation of prejudice. I was able to establish several things. First, the scientific literature on phenotypicality bias remains relatively unexplored and has been considered mainly in the United States using face stimuli of males. Second, the multiplicity of methodologies makes it difficult to establish a clear finding or to identify factors that would allow one to draw conclusions about the strength of the effect of

perceived ethnic typicality on the activation of ethnic prejudice. However, this phenomenom has been replicated on different occasions, through different measures and in different contexts. This may provide some evidence of the importance of this bias. Importantly, this systematic review has raised the importance of considering the occurrence of ethnic discrimination applying to the ethnic group in a homogeneous manner. It establishes the notion of differential treatment within stimulus groups, where perceived ethnic typicality influences the strength of activation of group prejudice. Finally, this systematic review identified a series of methodologies for manipulating perceived ethnic typicality that could be used for further study, which proved useful in my own case.

In the final experiment, I assessed the impact of perceived ethnic typicality on the OGRB while considering potential interactions with social contact patterns and prejudice. I was able to identify an effect of perceived ethnic typicality but only for the experimental condition contrasting European and North-African stimuli. Moreover, this effect showed a direction opposite to that expected, i.e., a better recognition performance for highly typical individuals compared to individuals perceived as less typical of their ethnic group. Finally, I did not find any interaction effects between the social variables of social contact and ethnic prejudice and variations in perceived ethnic typicality.

Contributions of the present thesis

Although the work carried out in this thesis has not validated all the hypotheses postulated, a number of points should be borne in mind.

Firstly, the thesis has contributed to the study of recognition difficulties of European-French participants for North-African faces, a topic for which relatively little data exists.

A second point concerns the work around the conceptualisation of social interactions with regard to their impact on the OGRB. I do not claim to have offered an exhaustive review of the modalities of intergroup social interactions or to have developed a scale capable of comprehensively measuring patterns of social contact. However, I consider that the approach outlined in this thesis fills a certain gap in the literature regarding the importance of social ecology of contact. The tools developed, specifically the contact questionnaire, could be reused, completed and/or translated in the context of work on the OGRB and social contact or in general studies of social interactions. The items on contact avoidance in my view represent a substantial contribution. Furthermore, the contact avoidance scale has the potential to be adapted to different groups, including ethnic and non-ethnic groups. The explicit measures of

prejudice translated and tested here could also form the basis for the development of a prejudice scale which has the advantage of being designed for the study of prejudice towards North-African individuals, for which research goal few materials and tools are available.

A third point concerns the systematic review on the phenotypicality bias. Although it did not include a meta-analytic component, it addressed a recent, and small literature that has important social implications. In addition, this work has been particularly useful for me in conceptualising and reflecting on methodologies for researching the effects of perceived ethnic typicality. Ideally, this review could encourage future research on this topic, especially considering the limitations presented such as the exclusive USA basis of studies, and the absence of the study of interaction effects with gender.

Finally, the work on perceived ethnic typicality and its impact on face recognition is particularly important. Although the main hypothesis of this procedure, namely the impact of ethnic typicality on OGRB, did not yield the expected results, the literature in this area is so sparse that my findings contribute to the understanding of within-group variability on face recognition. Although my inability to confirm my hypotheses may be due to various factors, including the material used, I remain convinced that future research should continue to explore this line of inquiry. More generally, I believe that the issue of within-group variability should be given more prominence in OGRB studies and that the prevailing assumptions of homogeneity of ethnic group should be clearly addressed.

This thesis work also has the merit of having attempted to conduct complex experiments for which an important work of validation of the material has been carried out. In particular, some effort has been made to construct standardised material adapted to the limits of the disciplinary field.

Limits and challenges of the present research

The work carried out in the framework of this doctoral project can be criticised in several respects. A first point concerns the statistical power achieved in the two experimental procedures, which partly depends on the number of participants recruited. It seems possible that the failure to achieve statistical significance in the tests of some hypotheses, and the small effect sizes observed, can be explained, among other things, by the lack of power. This could be problematic in that it could lead to biased conclusions of absence of effects (Turner et al., 2013). In turn, this could deepen the replication crisis in psychology, even if just slightly. Furthermore, given the complexity of the experimental designs carried out, especially for the

first experiment, it is possible that the analyses I carried out were too ambitious. This is certainly an important challenge to consider when conducting procedures that manipulate and measure a multitude of elements.

Another point to raise concerns the practices of Open Science and in particular the process of pre-registration of hypotheses, and experimental and analytic methods. This practice could have benefited my work in several ways. As Lakens (2018) points out, the primary value of registering an experimental procedure and statistical design is not only to make this information public but also to push the researcher to consider several points of reflection around the method and hypothesis testing before starting the collection of data. Although this limitation is unfortunate, it should be noted that each experimental procedure was reviewed by the Toulouse Research Ethics Committee (CER[17]) for which I obtained a favourable opinion before data collection, and I was awarded an IRB number for the first experiment confirming this. The preparation of these submission files pushed me to reflect, share and plan different elements that meet the goal of pre-registration, namely, the experimental hypotheses and the statistical design. As part of my co-supervision with the University of Cape Town in South Africa, I also submitted my experimental procedure to a dissertation evaluation committee as part of the Phd Proposal. These two processes do not replace pre-registration processes but facilitate good research practice.

A third point of interest concerns the population studied in this thesis, which consisted solely of 'White' Europeans. It is regrettable that my work could not use fully-crossed and replicated designs in different countries. Ideally, it would have been very interesting to have a cross-sectional angle on these experimental procedures. Although the study of North-African stimulus group was useful, given the lack of knowledge about North Africans, it would have been even more interesting to also have a participant group that included North-African individuals. I considered the problem of recruiting participant populations so as to constitute a fully crossed OGRB design, several times. One of the first obstacles is how to recruit participants by setting an inclusion criterion based on ethnic group. In France, as stated previously, ethnic statistics and direct questions evaluating racial/ethnic identity are prohibited by law. This also necessitated a reflection, with consultation of the Toulouse CER, to find solutions for the identification of participants' ethnic groups. The method used in this PhD, which consists of cross-referencing grandparents' country of birth with self-reported phototype,

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[17] Comité d'Ethique de la Recherche de Toulouse

is not ideal but is often used in France. However, it was not as easy to implement this technique during the participant recruitment phase. It was also not possible to state the required ethnicity of participants explicitly in recruitment advertisements at the University or on social networks. Ideally, it would have been better to consider an alternative sampling method that would have allowed access to other populations and in particular individuals of North-African descent. I also think it is important to continue to challenge the way one approach the categorisation of ethnic groups as researchers and experimenters. Safi (2013) suggests that when working with ethnic categories, one should always offer a double ethnic categorisation, i.e., a self-identification of the group and an assessment by a third person (or even a group of third persons). This cross-categorisation should be considered for both the stimulus and participant ethnic groups. This process was implemented in my thesis for the ethnic group of my stimuli but was not implemented for the ethnic group of my participants.

This leads me to criticize my approach to ethnic group categorization through questions on grandparents' country of birth and self-declared phototype. This would suggest that I have considered geographical origin and self-declared skin colour to be sufficient to determine an ethnic group. However, in the second part of my work I have emphasised that there is more to ethnic group than these criteria. In this case, I only used this categorisation to identify European participants from other ethnic groups and thus define an inclusion criterion. I therefore believe that the consequences of this categorisation in my case are reasonable. However, I would suggest to other researchers, especially in France, to use another solution for ethnic identification.

Regarding the replication of my experimental procedures in other countries, it should be noted that the Covid-19 pandemic made this exercise more difficult. Initially, it was considered to replicate the experimental procedures in South Africa at the University of Cape Town. Data collection in a Maghreb country could also have been considered. This would have made it possible to 1) replicate the different procedure and gain confidence in the general conclusion regarding results obtained; 2) evaluate the potential differences between cultural settings; 3) include other ethnic populations than those included in the French work. For this purpose, there are guides in the literature accompanying the practice of replicating procedures in cross-cultural settings that can be drawn upon (Milfont & Klein, 2018). In addition, it is in line with combatting aspects of the reproducibility crisis and the approach taken by the 'Reproducibility Project: Psychology' (Open Science Collaboration, 2015). There is no doubt that fully crossed models, replicated in several social contexts, could have greatly benefited not only my work but can benefit OGRB studies in general. It is typically this kind of work that

can lead to new lines of research such as perceived ethnic typicality and the existence of within-group variability, as demonstrated for example in the work of Chiroro et al. (2008).

Then, a fourth point of importance in the challenges encountered concerns the lack of clear results on the impact of social contact on recognition performance. Specifically, I was unable in my two experiments to show that social interaction patterns were a determinant of face recognition abilities. As expressed in Chapter 2, there are several explanations for this. On the one hand, it is possible that the measurement tool, the choice of population (mainly students), the number of participants or the ethnic groups of the stimuli studied were not suitable for this demonstration. It is also possible that the effect of contact on the OGRB occurs within a critical period, similar to the language acquisition process (McKone et al., 2019), i.e., faces of own and other groups are learnt before age 12, and after that there is less capacity to learn groups of other faces. But it is also possible to suggest that the OGRB and the explanation of contact is much more rooted in a perceptual than a social framework. Because of this and coupled with the limited number of participants in my studies, it is possible that the effects of social contact are relatively small and difficult to observe. I consider, however, that the study of social contact remains important to consider in the study of recognition difficulties. I would encourage further work in this direction, particularly in procedures that manipulate social and visual contact. This could be done for example through serious games, or through procedures similar to the one implemented in my thesis.

A fifth challenging aspect of this thesis work, and the last I will mention here, was the validation of materials. Concerning the creation of the prejudice and contact scales, I have included an Appendix B, dealing in detail with the testing of these tools and the limitations encountered. One can add that the choice of an explicit measure of prejudice was perhaps not without consequences. Although I did consider using an implicit measure, it seemed to me that the use of a measure such as the Implicit Association Task (IAT) was not feasible, given the already cumbersome procedure for participants. Indeed, the participant were participating in a long and cognitively demanding task where eye movement but also heart rate variability were measured. More importantly, the validation of the stimulus photo material and particularly the creation of stimuli varying in perceived ethnic typicality proved to be much more onerous than expected. It seems to me that my approach to the creation of materials was thoughtful and attempted to provide suitable finished materials. I wonder, however, if other, less time-consuming alternatives might not produce similar or better results. As expressed in Chapter 4, the use of Artificial Intelligence models could allow the creation of an unlimited number of faces in a short time. Some AI can, from a textual description, create faces. However, it would

be necessary to consider a technique for assessing the perceived typical ethnicity of different groups beforehand. This data could form a database that could be used in the description of faces implemented in the AI that artificially creates the faces. For example, it could be envisaged to set up semi-structured interviews with a large number of participants, where they would be asked to describe an individual perceived as ethnically typical of a category. This type of interview could also be conducted using existing photographic material where the participant would be asked about their perception of the typicality of the different faces presented. The latter technique would also provide information on what is perceived as atypical of a given ethnic group. The final objective would be to retrieve textual descriptive data which could then be qualitatively analysed and used as a basis for an AI model.

Opportunities for future research

Although I made a considerable effort to include social contact that had an ecologically sensitive component, there are many other possibilities. For example, some of the literature on intergroup relations and prejudice also considers the study of indirect contact. This includes the study of vicarious, imagined, extended, mediated contact, etc. (see Dovidio et al., 2017, for a review of the existing measures). Although this was not explored in this thesis, the inclusion of indirect contact in OGRB studies may be of interest. Indeed, social contact as studied in the face recognition literature focuses on the direct aspect of contact, i.e., social interactions between at least two protagonists, usually face to face. However, one can consider the interest of extending the study of contact to its indirect version. This would include exposure to media, film, imaginary interactions, friends networks of friends, and so on. The literature on this indirect contact in the context of the Contact Theory test is very large and continues to expand. For example, there are an important number of meta-analyses on the effects of indirect contact (e.g., Banas et al., 2020; Zhou et al., 2019). I believe that the study of indirect contact could complement the study of direct contact and provide contextual elements that could be important to the development of perceptual expertise, as is thought to underly the OGRB. Of course, indirect contact where no face encoding is done (as is the case in the imagined contact) could have a very limited impact on the OGRB and would not necessarily be included. However, indirect contact where visual exposure is activated could be quite interesting to include. For example, in countries where an ethnic group is under-represented on television and in the media, there may be less indirect contact, potentially reducing a gain of expertise for this group. No work, to my knowledge, has directly explored indirect contact in the context of the OGRB.

I also think that the indirect contact approach could be particularly interesting, especially after the COVID 19 pandemic which has pushed us to use many more sources of information and digital communication, in which indirect contact is central. In the same perspective, the increasing use of social networks could also lend itself to this study of indirect contact.

With regard to the study of contact avoidance, I consider that it deserves further exploration in several ways. Firstly, in informal discussions with the participants in my first experiment, I found that many of them indicated that they were very conscious of avoiding physical contact, particularly on the street. This avoidance of contact was not necessarily directed towards an ethnic group but rather towards a gender group: men. The gendered occupation of urban space has been the subject of social science research all over the word and specifically in respect to street harassment and the gendered feeling of being unsafe (e.g., Ahmad et al., 2020; Condon et al., 2007; Dhillon et Bakaya, 2014; Lieber, 2002, 2008; Lynn, 2009). These studies conclude with the finding that the occupation of urban space differs between genders and that women adapt physical avoidance strategies when they move around the city. Thus, it seems that this behaviour, which I have studied here between ethnic groups, is also gender dependent. This may be particularly important when considering the potential strength of this behaviour in women and may require future research. As OGRB also occurs in gender groups, thus there may be a line of research to invest in patterns of contact avoidance between ethnic and gender groups and the potential impact this may have on face recognition.

Another line of research concerning the avoidance of contact could concern visual behaviour during cross-group social interaction. In my approach of avoidance of contact, I addressed two different components the physical avoidance, that could occur in public spaces and the avoidance of specific conversation subjects during a social interaction. Physical avoidance is interesting to explore because it highlights the impossibility of social interaction. However, as for the pattern of avoiding particular subjects of conversation, contact avoidance can also occur during social interaction in the form of gaze avoidance. Howell and colleagues (2016) found that individuals with high levels of social anxiety tended to avoid the gaze of their interlocutor. Given the link highlighted in the first part of this thesis of the anxiety-provoking reality of intergroup interactions (Richeson & Shelton, 2007; Vorauer & Kumhyr, 2001), it would be interesting to exploit how this may impact gaze avoidance. This could be done in several ways: it is possible to consider recording participants' eye movements during cross-group face-to-face interactions using eye-tracking glasses. This type of procedure has already been used in studies of social interactions (Rogers et al., 2018) and cross-group interactions (Brunet et al., 2022). It is also possible to use a similar technique to the one used by Howell et

al. (2015) and record eye movements with a fixed, more reliable eye-tracker and organise social interactions via webcam. Following these procedures, it could be envisaged to carry out a recognition task including the individuals with whom a social interaction has taken place. This type of procedure could be particularly interesting for several reasons. Firstly, it would allow us to study a form of contact avoidance on the OGRB. Secondly, it would provide more information about the visual strategies employed across ethnic groups, stimuli and participants. Indeed, if one place this procedure in the context of the study of visual scanning, it is possible to test the existence of group-dependent differential processing. The majority of the studies presented on visual scanning so far postulates a difference or absence of difference in the type of encoding between groups but only for static face stimuli. However, the encoding of faces in real conditions is based on a set of dynamic situations, often far from the condition of static photos on a screen. The interest of a procedure such as the one suggested here would be to give a much more ecologically sensitive evaluation of the visual strategies used. It would thus be possible to highlight differences in the visual strategies employed between ethnic groups, which would depend in part on gaze avoidance.

Then, concerning the approach to within-group variability, it seems necessary to continue and replicate work in this area. First, in light of my review of the literature on phenotypicality bias, it seems necessary to conduct procedures for replicating this effect on attitude activation. As raised in my findings, this bias is sorely lacking replication studies outside the United States. It could also benefit from more input on the use of female stimulus faces and exploration of this effect among diverse ethnic groups such as North-Africans in France.

Regarding the link between perceived ethnic typicality and OGRB, it seems necessary to pursue this line of research as well. It is surprising that within-group variability has not received more attention in the study of the OGRB. The type of procedure used in my chapter 4 could be replicated with several populations and by considering several methodologies for modifying this perceived ethnic typicality as discussed earlier. In addition, perceived ethnic typicality could also be incorporated into experiments on visual strategies. In this context, it would be necessary to investigate the existence of potential differences in visual scanning as a function of perceived ethnic typicality. The hypotheses postulated about a lack of adaptation of visual strategies according to ethnic group, i.e., fewer well adapted visual strategies to correctly and efficiently encode out-group faces, could be applied to faces perceived as very typical as well.

Finally, future research could also combine the two opening points discussed above, namely the exploration of contact avoidance and within-ethnic variability in face recognition. Indeed, considering the work of Hebl and colleagues (2012) on social rejections and the tendency to have fewer cross-group friends for individual perceived as highly typical of an ethnic group, one could explore how it could also impact on interaction avoidance. As discussed earlier, contact avoidance could again be studied in several ways, either through self-reported patterns of avoidance or based on avoidance behaviour during interactions. For example, one can imagine a procedure where cross-group social interactions would be conducted with individuals presenting different levels of perceived typicality. As for the previous procedure discussed earlier, an eye-tracking device could be used in order to account for gaze avoidance behaviour and more generally face scanning. This task could also be associated with a face recognition task and eventually a self-report questionnaire of social contact and prejudice. Of course, it should be borne in mind that this type of very complex and exploratory experimentation requires both a large number of participants and material and human resources. Thus, this is a proposal that might need to be adapted and broken down into several experiments.

Conclusions

The work presented in this thesis had many objectives. The two major goals were to thoroughly evaluate both the impact of cross-group social interaction and within-group variability on face recognition. The results obtained did not allow a clear conclusion on the impact of one or the other of these variables. However, some interesting leads seem to have emerged, notably on the manipulation of the social contact set up in the first experiment and its impact on visual face scanning strategies. As mentioned above, it is possible that the social aspect of contact does not play a major role in the development of the OGRB or that its importance is defined by other elements such as a critical period (McKone et al., 2019). This does not change the importance of continuing to study this bias and understanding its social and cognitive implications. The inability or difficulty in recognising someone has a significant impact on individuals at different levels. As presented in the general introduction, this recognition bias continues to have many consequences in judicial settings, jeopardising the liberty of individuals. But more generally, this recognition bias also has an impact on our intergroup social relations. It is therefore essential to further investigate all the elements

surrounding the OGRB. Finally, it seems that links can be made to other types of attitudinal bias and that elements such as within-group variability should not be underestimated. OGRB is a complex phenomenon with diverse implications and approaches that can be cognitive, social and developmental. I hope that this thesis has made a small but significant contribution to its understanding.

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Résumé de la thèse en Français

Chapitre 1 - Cadre théorique
Le biais de reconnaissance endo-groupe (BRE)

Un phénomène très étudié, appelé le biais de reconnaissance endo-groupe (BRE), est l'un des biais les plus connus dans la reconnaissance des visages. Il peut être défini comme la difficulté à reconnaître et à discriminer les membres d'autres groupes par rapport à son propre groupe (Malpass & Kravitz, 1969 ; Chance & Goldstein, 1996). En particulier, une partie importante de la littérature sur le BRE s'est concentrée sur les difficultés à reconnaître les membres d'autres groupes ethniques ou raciaux. Une méta-analyse publiée par Meissner et Brigham (2001) couvrant 30 ans de recherches sur ce sujet a indiqué qu'un individu est presque 1,5 fois plus précis pour reconnaître les individus de son propre groupe ethnique que les autres. À l'inverse, les individus ont 1,56 fois plus de chances de reconnaître par erreur des personnes appartenant à d'autres groupes comme étant des personnes qu'ils ont déjà vues auparavant.

Comptes rendus théoriques du BRE
L'hypothèse de l'expertise perceptuelle

La plupart des comptes rendus du BRE dans la littérature s'inscrivent dans ce que l'on peut appeler la théorie de « l'expertise perceptive » (également appelée « apprentissage perceptuel »), selon laquelle notre perception des visages est façonnée par nos expériences visuelles individuelles. L'exposition à des individus d'un même groupe permet d'acquérir une expertise perceptuelle pour les visages de ce groupe. Cette expertise sera moins développée pour les visages d'autres groupes car l'exposition à ces visages est généralement plus rare. Selon cette hypothèse, les individus exposés à un nombre important de membres d'un autre groupe pourront acquérir une expertise pour les visages de ce groupe et ainsi réduire les effets du BRE (e.g., Sporer, 2001).

L'explication socio-cognitive

Selon Sporer (2001), le BRE est causé par une différenciation des processus cognitifs utilisés, qui est induite par une catégorisation dichotomique du stimulus comme étant "endo-groupe" ou "exo-groupe ". Les individus issus d'autres groupes sont donc davantage perçus comme représentant un stéréotype de leur catégorie, au détriment d'éléments individualisants (Levin, 2000). En revanche, les individus du même groupe bénéficient d'un traitement cognitif

plus profond, leur permettant d'acquérir des informations individualisantes ce qui facilite ensuite la reconnaissance des visages.

Dans l'ensemble, les modèles explicatifs socio-cognitifs du BRE supposent tous que l'expérience perceptuelle est importante, mais tiennent à qualifier ce qui modère les effets de l'expertise perceptuelle. Sans être totalement exclusifs (par exemple, le CIM), les modèles socio-cognitifs minimisent, voire contredisent, les effets de l'apprentissage perceptuel en faveur de la catégorisation sociale. Le BRE ne serait donc pas tant le résultat d'une exposition visuelle qu'un processus de catégorisation ethnique prédominant qui empêche un processus d'individuation optimal. Cependant, l'explication catégorielle a souffert d'un manque de réplicabilité dans la littérature, spécifiquement concernant ses études clés.

Au delà de la simple exposition : adaptation de la théorie du contact

La quantité de contact est-elle suffisante pour rendre compte de l'expertise perceptuelle ? En 1954, Allport a présenté la théorie du contact, qui prédit une forte relation entre les préjugés et le contact social. Le contact social avec les membres d'un autre groupe, sous certaines conditions, est associé à une diminution des préjugés envers les membres de ce groupe. Cette théorie a été largement soutenue dans les recherches ultérieures (voir Pettigrew & Troop, 2006, pour une méta-analyse de plus de 500 études) et peut être adaptée au domaine de la reconnaissance des visages. La qualité de l'interaction sociale semble être spécifiquement importante pour avoir un effet positif sur les attitudes (Pettigrew et al., 2011) et certaines études sur le BRE tendent à présenter des résultats similaires.

Contact social, BRE et stratégies visuelles

J'ai établi que les interactions sociales et l'exposition visuelle répétée à des visages d'un groupe ethnique particulier semblent être particulièrement importantes pour expliquer les effets du BRE. Il reste cependant à exposer comment le contact réduit ces difficultés. Pour répondre à cette question, on peut s'intéresser au traitement visuel des visages et à la façon dont les interactions sociales répétées pourraient moduler les stratégies visuelles. Le BRE reflète, comme son nom l'indique, une difficulté à reconnaître les visages d'exo-groupes. Certains auteurs ont postulé que cette difficulté de reconnaissance pouvait être due à des stratégies visuelles moins bien adaptées à la reconnaissance des visages des exo-groupes. Un sous-domaine important de la littérature sur la reconnaissance des visages utilise des mesures d'eye-tracking pour retracer les stratégies visuelles utilisées pendant l'encodage des visages (par exemple, Arizpe et al., 2016 ; Hsiao & Cottrell, 2008 ; Williams & Henderson, 2007).

Bien qu'il ne soit pas possible d'atteindre un consensus sur l'utilisation de stratégies visuelles à travers les groupes (voir Stelter et al., 2021, pour une revue), il semble y avoir un

élément de non-adaptabilité de ces stratégies dans le cas de visages d'exo-groupes. Il n'est donc pas aisé de faire des prédictions avec certitude sur le type de stratégies visuelles employées lors de la visualisation d'exo-groupes. Cependant, on peut s'accorder sur le fait qu'il existe probablement un décalage dans les stratégies visuelles lorsqu'on regarde des membres d'autres groupes. Il semble également que l'interaction avec les membres d'exo-groupes, par l'augmentation de la familiarité des visages, peut favoriser des changements dans les stratégies visuelles qui sont plus susceptibles d'être appropriées pour une reconnaissance efficace.

Limites du contact social

Dixon et ses collègues (2005) ont publié un article dans lequel ils remettent en question la réalité de la théorie du contact. Ils soutiennent que l'étude du contact souffre d'une déconnexion avec la réalité des interactions sociales. Parmi les limites mentionnées figure la nature du contenu des interactions intergroupes, qui, au-delà de la simple quantité ou qualité, peut aussi être plus ou moins superficiel (Marsden, 1987) ou dans lequel certains sujets seront évités. Ce dernier élément a été discuté dans un ensemble de travaux appelés « micro-écologie du contact », qui visent à décrire le modèle d'interaction entre les groupes ethniques dans différents contextes écologiques. Il existe notamment un ensemble de données d'observation sur les comportements d'interaction sur les plages (Dixon & Durrheim, 2003), mais aussi dans les universités et les écoles publiques dans leurs cafétérias, leurs cours de récréation et leurs salles de classe (Alexander & Tredoux, 2010 ; Clack et al., 2005 ; Dixon et al., 2008 ; Koen & Durrheim, 2010 ; Tredoux et al., 2005). Cet évitement du contact, qui semble être un événement récurrent dans les situations écologiques, a cependant rarement été pris en compte dans l'étude des interactions sociales.

Plus récemment, des travaux ont également montré une forte concentration sur la notion de contact positif dans ce domaine, au détriment du contact négatif. En effet, les études sur les modèles de contact dans la littérature sur la théorie du contact ont surinvesti l'occurrence de contacts positifs, tels que les amitiés. Il est cependant important de rendre compte de la réalité des amitiés intergroupes, qui, bien qu'efficaces pour réduire les préjugés, ne sont en fait pas très courantes. Barlow et al. (2012) ont notamment indiqué que les contacts négatifs sont plus fortement corrélés aux préjugés et aux comportements discriminatoires que les contacts positifs. Compte tenu de son effet sur les préjugés, et parce que le contact négatif semble être un meilleur prédicteur de l'évitement des contacts que le contact positif (Hayward, 2016), il semble important de prendre en compte le contact négatif dans l'étude des interactions sociales, ne serait-ce que pour refléter la réalité des interactions sociales de manière plus écologique.

Nous avons établi ci-dessus qu'il existe un fossé entre la manière parfois utopique dont le contact a été étudié en psychologie sociale et l'écologie de l'occurrence et des cadres des interactions intergroupes. La réalité de l'évitement significatif du contact soulève une question importante : pourquoi le contact intergroupe est-il généralement évité ?

L'anxiété de l'interaction

Cette notion de peur de la confrontation intergroupe et du contact négatif soulevé dans les groupes de discussion de Schrieff et al. est illustré par la réalité anxiogène des interactions de groupe mise en évidence par Richeson et Shelton (2007). Il a été démontré que l'interaction avec un individu d'un exo-groupe ethnique provoque un malaise et une détresse chez ses protagonistes (Vorauer & Kumhyr, 2001).

Cette anxiété face aux interactions intergroupes pourrait également être accentuée par le BRE lui-même. La difficulté à reconnaître les visages a un impact à la fois sur les observateurs et sur les individus perçus. Pour les deux protagonistes, les interactions intergroupes seront donc potentiellement anxiogènes et pourront conduire à des stratégies d'évitement. Brigham et Malpass (1985) ont confirmé qu'une mauvaise identification pouvait également accroître l'hostilité, la méfiance et les stéréotypes entre les groupes. Dans ces conditions, il est compréhensible que l'établissement d'une relation sociale entre deux individus appartenant à des groupes différents puisse être difficile, surtout dans les premiers temps.

Préjugés

La notion de préjugé a déjà été abordée à de nombreuses reprises dans cette partie théorique. Il est difficile de ne pas mentionner les attitudes négatives lorsqu'on traite des relations intergroupes. Les préjugés ont parfois été testés directement en tant que prédicteur du BRE. Une grande partie de la littérature ne montre pas de relation directe entre préjugés et l'occurrence du BRE (par exemple, Brigham & Barkowitz, 1978 ; Lavrakas et al., 1976 ; Platz & Hosch, 1988 ; Slone et al., 2000 ; Swope, 1994 ; Yarmey, 1979). Il est possible que les préjugés n'aient pas un rôle direct sur le BRE mais agissent plutôt comme un modérateur via les expériences d'interaction sociale (Caroo, 1987). En effet, comme le souligne la théorie du contact (voir Pettigrew & Tropp, 2008, pour une revue), les préjugés sont fortement liés aux modèles de contact social. Les préjugés seront donc inclus comme variable d'intérêt dans cette thèse, étant donné leurs effets directs potentiels sur le BRE mais surtout leur lien fort avec les schémas d'interaction sociale.

Conclusion

J'ai présenté les différents liens existant dans la littérature entre différentes composantes sociales et cognitives gravitant autour de l'occurrence du BRE. Il en ressort une chaîne d'effets interconnectés qui pourrait être particulièrement importante pour comprendre ce biais. Selon cette idée, la faible quantité et qualité des contacts sociaux avec les membres d'un autre groupe ethnique peut augmenter l'anxiété envers ces membres, ce qui conduit à l'évitement des contacts. On peut s'attendre à ce que cela augmente les préjugés et la difficulté à reconnaître les visages des membres d'exo-groupe ethnique. Cette chaîne d'effets peut également être envisagée sous plusieurs angles : l'un d'eux pourrait être que les difficultés à reconnaître les membres d'autres groupes ethniques constituent un obstacle à l'établissement d'un contact, ce qui augmente l'anxiété liée à l'interaction avec un membre d'un exo-groupe, impliquant ainsi un contact faible et peu fréquent, ce qui entraîne à son tour une augmentation des préjugés. Afin d'étudier les différents effets principaux et d'interaction qui pourraient avoir lieu entre toutes ces composantes et en particulier sur la reconnaissance des visages, je propose une étude expérimentale précédée par la création et le test de matériel.

Chapitre 2 - Expérimentation 1

Description et objectifs

Les objectifs visés par cette étude étaient multiples. Le principal était d'évaluer comment le contact social peut moduler la reconnaissance des visages entre groupes. Compte tenu de la littérature sur le contact et le BRE, et en particulier l'étude de la micro-génèse du contact, une attention particulière a été accordée à la manière dont les modèles d'interaction sociale ont été évalués. Par conséquent, j'ai étudié une mesure du contact autodéclaré comprenant des dimensions sur la qualité du contact (contact positif et négatif), la quantité de contact et l'évitement du contact. J'ai également étudié de manière concomitante le niveau de préjugés envers les individus Nord-Africains à travers une échelle d'auto-évaluation traitant des aspects conatifs et affectifs des attitudes. Ensuite, j'ai inclus une manipulation de l'anxiété d'interaction intergroupe, dont on sait qu'elle est importante lorsque des groupes sont en contact. Cette étude a également évalué les stratégies de balayage visuel des visages par la mesure des mouvements oculaires.

Afin d'atteindre ces objectifs, les participants Européens ont été invités à effectuer une tâche de reconnaissance des visages dans laquelle ils ont essayé de reconnaître des individus Européens et Nord-Africains. Pendant l'encodage des visages, j'ai introduit une interaction sociale avec un membre de chaque groupe sur un service de messagerie instantanée. Ces interactions sociales ont été rendues plus ou moins anxiogènes dans trois conditions expérimentales entre les sujets (opérationnalisées en faisant varier l'expression émotionnelle des stimuli et la qualité de l'interaction sociale). L'anxiété liée à l'interaction a été mesurée à l'aide de diverses mesures d'auto-évaluation de l'anxiété et de l'excitation physiologique (*arrousal*). Après la phase de reconnaissance, les participants ont été invités à remplir une échelle évaluant les habitudes de contact social avec des personnes d'origine Nord-Africaine, ainsi qu'une échelle évaluant les préjugés envers les personnes d'origine Nord-Africaine. Pendant l'encodage et la reconnaissance des visages, les stratégies visuelles (le nombre de fixations et les temps d'arrêt) ont été mesurées avec un eye-tracker.

Résultats et discussion

Premièrement, la manipulation de l'anxiété d'interaction, testée à l'aide de trois mesures, n'a pas été pleinement réussie. La manipulation d'expressions faciales émotionnelles couplées à une attitude spécifique de l'interlocuteur pour induire différents niveaux d'anxiété n'a pas non plus fonctionné. Lorsqu'une différence a été constatée entre les conditions, elle semble aller

dans le sens inverse de ce qui était attendu, la condition « heureux/amical » générant plus d'anxiété que les autres conditions.

En ce qui concerne les mesures des préjugés et du modèle de contact social, il existe des corrélations entre ces facteurs qui corroborent la littérature. Le contact social (quantité et qualité) est corrélé négativement avec le niveau de préjugés, comme prévu. Concernant l'ajout de l'évitement des contacts, qui est l'une des nouveautés expérimentales de cette étude, on peut également noter une corrélation négative significative avec les modèles de contacts sociaux et une corrélation positive stable avec les préjugés. Ces résultats confirment donc les hypothèses faites sur ces mesures.

En ce qui concerne les performances de reconnaissance des visages, les données ont été modélisées de trois manières différentes afin de rendre compte au mieux de leur complexité. Il a été montré que le groupe ethnique avait un impact sur les performances de reconnaissance, avec de meilleures capacités de reconnaissance pour les visages européens (endo-groupe) par rapport aux visages nord-africains (exo-groupe). Cet effet confirme donc l'existence d'un BRE sur une population européenne vis-à-vis des individus nord-africains . Il existe également un effet tendanciel du contact auto-déclaré sur les capacités de reconnaissance, en particulier pour les visages nord-africains. Des niveaux élevés de contact autodéclaré avec cette population peuvent être associés à de meilleures performances de reconnaissance pour les individus de ce groupe. Cependant, cet effet n'a pas atteint le seuil de signification et il convient de faire preuve de prudence dans son interprétation. Aucun autre effet n'a pu être trouvé. Les hypothèses concernant le contact, qu'il soit manipulé ou rapporté, et les interactions potentielles avec les préjugés et l'anxiété d'interaction n'ont donc pas pu être confirmées.

Enfin, en ce qui concerne les stratégies visuelles, l'analyse du nombre et de la durée des fixations indique que la partie supérieure du visage attire la plus grande partie de l'attention visuelle, tant pendant l'encodage que pendant la reconnaissance. Et ceci était vrai pour les visages Européens et Nord-Africains, ne permettant pas de soutenir l'hypothèse d'une différence de stratégies visuelles en fonction du groupe. En outre, la manipulation du contact semble avoir eu un impact sur les deux indicateurs de stratégies visuelles pendant la reconnaissance. Les stimuli encodés avec un contact social ont bénéficié d'une concentration visuelle moindre pendant la reconnaissance, avec notamment moins de fixations et des fixations plus courtes que les stimuli encodés sans contact. Ces résultats soutiennent partiellement l'hypothèse d'un impact du contact social sur les stratégies visuelles, bien qu'il soit présent pour tous les visages du groupe de stimulus.

Bien que cette étude n'ait pas corroboré toutes mes hypothèses, elle apporte de nouvelles perspectives dans l'étude de la reconnaissance intergroupe des visages. Un BRE a été démontré avec une population de stimulus rarement étudiée, les individus Nord-Africains. Compte tenu du contexte migratoire français et des relations parfois tendues entre Français « blancs » et Maghrébins, la mise en évidence de ce biais est importante. Cette étude a également apporté de nouveaux éléments à l'étude des stratégies visuelles lors de l'encodage et de la reconnaissance des visages. Selon cette expérience, il ne semble pas y avoir de différences significatives dans les stratégies utilisées par les individus Européens face à un visage Européen ou Nord-Africain. Cependant, cette information doit être confirmée et testée dans d'autres expériences et en considérant l'utilisation d'autres mesures de stratégies visuelles. Par ailleurs, les résultats concernant les variables sociales dans l'étude du BRE peuvent sembler légers en ce qui concerne les performances de reconnaissance des visages, mais des éléments intéressants émergent de l'étude des stratégies visuelles. Dans cette étude, bien que les modèles d'interaction sociale ne semblent pas avoir un impact significatif sur les stratégies visuelles, la manipulation d'un contact social en direct a un impact significatif sur les modèles visuels du nombre et de la durée des fixations. Il semble important de souligner que, avec le recul, ce type de protocole et la prise en compte des différents facteurs mentionnés restent ambitieux et impliquent des contraintes méthodologiques et statistiques importantes. Il ne s'agit pas pour autant de nier que ce type de protocole complexe mérite d'être utilisé.

Chapitre 3 – Revue systématique sur le biais de phénotypicalité

Dans cette seconde partie de ma thèse, j'ai étudié la notion de variabilité intra-groupe et en particulier la façon dont elle peut avoir un impact sur la reconnaissance des visages entre groupes. Cet angle différent sur un aspect du BRE a été réalisé car la notion de variabilité perçue au sein du groupe est rapidement devenue une notion centrale dans mon étude du biais et m'a semblé tout à fait importante à considérer dans mon travail de thèse. En effet, cette notion renvoie directement à la conceptualisation que l'on peut avoir de ce qui constitue un groupe ethnique. Que ce soit dans les populations et les stimuli étudiés, dans le choix du matériel photographique, dans la construction des échelles de préjugés et des modes de contact, ou dans l'exploration des scans visuels utilisés lors de l'encodage d'un visage, la notion de groupe ethnique et ce qu'elle représente de différentes manières s'est avérée primordiale. De plus, la conceptualisation du groupe ethnique et de sa variabilité intra-groupe dans le cadre de l'étude du BRE est d'autant plus importante à prendre en compte qu'il existe peu de travaux sur le sujet. Pour ces raisons, j'ai concentré dans cette deuxième partie de ma thèse un focus sur cette notion de variabilité.

Le concept de groupe ethnique/racial

La question de la typicité ethnique perçue a été abordée en psychologie sociale, et plus particulièrement l'impact qu'elle peut avoir sur la perception sociale d'un individu. Une ligne de recherche importante repose sur l'existence d'un biais attitudinal qui pourrait être activé par la typicité ethnique perçue. En 2004, Maddox a passé en revue la littérature sur ce phénomène, qu'il appelle le « biais de phénotypicalité ». Dans son travail, Maddox souligne l'existence de nombreuses conséquences liées à cette variabilité ethnique perçue. Il soulève notamment l'impact de cette typicité sur les croyances, les sentiments, l'évaluation et le traitement des individus. Ce biais est également connu sous d'autres termes, étudiés à travers différentes disciplines des sciences sociales. On le retrouve notamment sous le nom de « *colorism* », de préjugé perceptif, de « biais de la couleur de la peau » ou d'afrocentricité (et inversement d'eurocentricité). Maddox définit le phénomène du biais de phénotypicalité comme suit : les individus évalués comme particulièrement typiques d'un groupe ethnique spécifique seront plus susceptibles d'être considérés à travers le prisme des stéréotypes, des croyances et des préjugés associés à leur groupe. Par conséquent, au sein des groupes ethniques qui font l'objet d'une discrimination, les individus peuvent recevoir un traitement différent en fonction de la mesure dans laquelle ils correspondent au prototype physique perçu de leur groupe. Plus un individu

présente des caractéristiques physiques qui le conduisent à être perçu comme typique de son groupe, plus il recevra un traitement discriminatoire.

Aperçu de la revue systématique

L'objectif de cette étude était de fournir une revue systématique sur le sujet du « biais de phénotypicalité » en ce qui concerne l'activation des préjugés ethniques. Plus précisément, j'ai tenté de répondre à la question suivante : Comment la perception de la variabilité de l'apparence physique d'exo-groupes au sein d'un même groupe affecte-t-elle les préjugés envers ces groupes ? Pour ce faire, j'ai utilisé une méthodologie reproductible, celle de la revue systématique de la littérature en suivant le guide fourni dans le travail de Siddaway et al. (2019). Plusieurs étapes ont été nécessaires. Sur la base de la spécification de la question ci-dessus, une stratégie de recherche pour trouver des articles pertinents a dû être mise en place, consistant en une recherche méticuleuse et documentée dans les bases de données. Ensuite, un filtrage des articles selon des critères d'exclusion et d'inclusion définis a été effectué. Puis, une deuxième collection d'articles a été identifiée en exploitant la bibliographie de cette première sélection de travaux et des revues supplémentaires sur le sujet. J'ai ensuite extrait, avec l'aide d'un second codeur, un ensemble de données (par exemple, les informations méthodologiques, les principaux résultats) pour chacun des articles sélectionnés. Cette étape a permis une évaluation qualitative des travaux sélectionnés Enfin, une synthèse narrative des principaux résultats des études retenues pour la revue a été réalisée.

Discussion

Grâce à cette revue systématique de la littérature, il est possible d'évaluer l'impact de la typicité ethnique perçue sur les attitudes intergroupes. Tout d'abord, les études sur l'activation des stéréotypes raciaux montrent que les individus qui sont particulièrement typiques du groupe « Africain/Noir » seront plus fortement associés aux stéréotypes de ce groupe, en particulier aux stéréotypes négatifs. Cet effet est également partiellement retrouvé chez les individus "Blancs" ayant des caractéristiques afrocentriques, avec une activation plus forte des stéréotypes du groupe africain pour ces individus que pour les « Blancs » ayant des caractéristiques eurocentriques. Ensuite, un autre groupe d'études montre que la variation au sein du groupe conditionne également l'attribution des traits. Que ce soit au sein du groupe hispanique ou africain, des différences dans l'attribution des traits sont constatées en fonction de la typicité ethnique perçue de l'individu. Ces attributions de traits reflètent les stéréotypes sous-jacents aux différentes catégories ethniques/raciales et sont généralement négatives. Enfin, les études sur les attitudes affectives des participants montrent une évaluation implicite et parfois explicite plus négative des individus présentant des caractéristiques afrocentriques

(qu'elles soient définies par la couleur de la peau, les traits du visage ou les deux). Là encore, ces résultats se retrouvent également chez les individus « Blancs » présentant des caractéristiques afrocentriques, mais dans une moindre mesure.

En conclusion, la typicité ethnique perçue intra-groupe a un impact sur les attitudes par le biais d'un certain nombre d'éléments différents. En général, les individus présentant des caractéristiques typiques d'un groupe stigmatisé (comme les « Noirs » ou les « Hispaniques ») auront tendance à activer les stéréotypes raciaux associés au groupe en question chez un observateur « blanc ». L'évaluation affective ou cognitive qui en résulte est généralement plus négative pour ces individus que pour leurs homologues présentant des caractéristiques moins typiques du groupe discriminé, ou plus typiques du groupe dominant (« Blancs »). Cette revue nous renseigne également sur la conception même de la variation intra-groupe. Issue d'une importante tradition de recherche sur le « colorism » (discrimination basée sur la couleur de la peau), la couleur de la peau a été considérée par de nombreux chercheurs comme un, sinon le, critère le plus important pour refléter la typicité ethnique. Cependant, plusieurs études montrent l'importance de considérer des éléments de typicité ethnique au-delà de la couleur de la peau. Certaines ont considéré la typicité ethnique perçue comme une caractéristique corporelle unique modifiant les attitudes (par exemple, Blair et al., 2002 ; Deska et al., 2020 ; Livingston & Brewer, 2002), d'autres ont plutôt considéré que la couleur de la peau et les caractéristiques faciales jouent un rôle similaire mais indépendant dans l'influence des attitudes (Hagiwara et al., 2012 ; Stepanova & Strube, 2012b) et enfin, d'autres ont exploré l'impact isolé de caractéristiques faciales telles que les cheveux (Kurdi et al., 2021 ; Opie & Phillips, 2015).

Finalement, bien que l'étude du biais de phénotypicalité mérite plus d'attention de la part de la psychologie sociale et en dehors des Etats-Unis, les travaux existants fournissent des éléments essentiels sur les notions de typicité des groupes ethniques et sur les attitudes intergroupes. Un élément à retenir est que les attitudes envers un groupe ethnique ne peuvent être considérées comme homogènes. Il faut reconnaître que parmi un groupe stigmatisé, certains individus subiront plus de discrimination, simplement parce qu'ils apparaîtront comme plus représentatifs physiquement de leur groupe. Enfin, cet élément pourrait être particulièrement important dans les études considérant les groupes ethniques comme homogènes et pour mieux comprendre et surmonter la discrimination entre et au sein des groupes.

Chapitre 4 – Expérimentation 2

Description et objectifs

L'objectif de la présente étude était d'évaluer comment la typicité ethnique perçue pouvait avoir un impact sur l'OGRB tout en considérant son lien avec les préjugés et les modes de contact. Pour ce faire, il a été nécessaire, en amont, de créer du matériel photo, avec différents niveaux de typicité ethnique perçue pour trois groupes d'intérêt : « Africain », « Européen » et « Nord-Africain ». Une fois ce matériel développé, j'ai construit une tâche de reconnaissance de visages avec trois groupes ethniques différents, où la typicité ethnique perçue était manipulée afin d'avoir des visages avec deux niveaux de typicité ethnique perçue : élevé et faible. Ce travail expérimental a permis d'explorer les différences de perception de la typicité ethnique à travers trois groupes ethniques de stimuli, mais aussi d'évaluer comment cette typicité peut avoir un impact sur le BRE, tout en considérant également les préjugés et les modèles de contact envers un exo-groupe ethnique.

Résultats et discussion

Les résultats de cette expérience fournissent plusieurs informations. Premièrement, un BRE a été reproduit dans les deux groupes expérimentaux, mais seulement dans la première modélisation des données qui n'incluait pas les variables sociales. Dans la deuxième modélisation des données, j'ai observé une reconnaissance généralement meilleure des visages de l'endo-groupe par rapport aux visages de l'exo-groupe, mais aucun effet d'interaction avec le groupe expérimental. Ce premier élément confirme partiellement l'hypothèse de la réplication du BRE pour nos deux groupes : Nord-Africain et Africain. De plus, la valeur du seuil de discrimination (d') et la taille de l'effet ($d_{Afr} = 0.20$ et $d_{Nafr} = 0.42$) étaient toutes deux faibles et seront abordées ultérieurement. Ensuite, la manipulation expérimentale, c'est-à-dire la variation de la typicité ethnique des visages, s'est avérée interagir avec le groupe de stimulus, mais dans les deux groupes de stimulus. Les visages à forte typicité ethnique étaient mieux reconnus que les visages à faible typicité ethnique. Cela confirme partiellement mon hypothèse d'un effet d'interaction entre le groupe et la typicité ethnique. Bien qu'un effet de double interaction incluant la typicité ethnique perçue ait été identifiée, elle a présenté, de manière surprenante, un schéma inverse à celui attendu, avec une meilleure performance de reconnaissance des visages pour les visages à forte typicité de tous les groupes ethniques stimulus par rapport aux stimuli à faible typicité. Enfin, les relations entre les mesures des préjugés, de l'évitement et des modèles de contact semblent correspondre à nos attentes et à la littérature dans les deux groupes expérimentaux. Cependant, ces différentes variables n'ont pas montré d'impact sur la capacité de discrimination lorsqu'elles ont été étudiées en interaction

avec la typicité ethnique perçue et le groupe ethnique des stimuli. Ces résultats infirment la dernière hypothèse prédisant un effet d'interaction entre le groupe de stimulus, la typicité ethnique perçue et les trois variables sociales.

Cette étude n'a pas permis de valider toutes les hypothèses postulées. Bien qu'il ait été possible de reproduire le BRE avec deux types de stimuli et qu'un effet de typicité ethnique perçue ait été démontré, il semble que ce dernier ne confirme pas les résultats présentés dans la littérature. Une fois encore, il n'y a pas eu d'effet des modes de contact et des préjugés sur le BRE, ni d'interaction entre ces variables et la typicalité. Cependant, il semblerait que la typicité ethnique ait eu un impact significatif sur les performances de reconnaissance, même si cela s'est produit de manière inattendue. Cela confirme la nécessité de considérer les groupes ethniques au-delà d'un ensemble homogène et de prendre systématiquement en compte la variabilité au sein du groupe dans les études sur le BRE. Deuxièmement, cette étude a mis en évidence la complexité de la conceptualisation, et donc de la manipulation de la typicité ethnique perçue. La façon dont j'ai traité et abordé le concept de typicité ethnique n'est qu'une des nombreuses façons possibles. Les recherches futures pourraient proposer d'autres protocoles utilisant l'intelligence artificielle, qui offre déjà de très bonnes alternatives, rapides et qualitatives, pour la création de visages. L'IA 'Stability Diffusion' (Stability.AI, Rombach et al., 2022) par exemple, offre la possibilité de générer un nombre illimité de photos en utilisant une courte description textuelle. Dans le cas de la création de photos de visages de typicité ethnique perçue variable, il serait possible, après la collecte de données qualitatives, d'établir des descriptions typiques d'individus de différents groupes et de typicité ethnique perçue afin de créer, à partir de ces éléments, des photos d'individus correspondant aux attentes du chercheur.

Chapitre 5 – Discussion générale

Objectifs de la thèse

Dans ce projet de thèse, j'ai abordé le BRE sous deux angles principaux. Dans un premier temps, j'ai testé l'impact des dimensions sociales, qui ont été mises en évidence dans la littérature comme importantes pour comprendre ce biais, sur les capacités de reconnaissance des visages. Dans une seconde partie, j'ai suggéré un lien potentiel entre le BRE et un autre biais attitudinal, le biais de phénotypicalité, que j'ai testé en manipulant la typicité ethnique perçue. L'objectif de cette thèse n'était pas de proposer une explication des origines du biais ou d'aborder un modèle complet de ses composantes. Il s'agissait plutôt de repositionner l'étude de l'OGRB, qui repose sur d'importants fondements cognitifs, dans un contexte social. Ce faisant, je voulais tester un certain nombre d'hypothèses sur la façon dont les variables sociales, mais aussi cognitives, interagissent et influencent les capacités de reconnaissance des visages.

Une partie importante de mon travail a consisté en une série d'études expérimentales approfondies des interactions sociales en relation avec la reconnaissance des visages, en tenant compte de l'importance du contexte écologique. Cela a conduit à la prise en compte de différentes sous-composantes du contact telles que sa valence quantitative et qualitative, mais aussi à la prise en compte d'éléments peu étudiés dans la littérature du BRE tels que le comportement d'évitement des interactions et l'anxiété intergroupe. Pour ancrer davantage mes études sur le plan social, j'ai inclus une mesure des préjugés, dont l'importance par rapport au contact social n'est plus à démontrer (voir Pettigrew & Tropp, 2006, pour une revue).

Une autre partie de mon travail a consisté à remettre en question la notion de groupe « ethnique » ou « racial » dans les études du BRE. Cela m'a conduit à explorer la variabilité au sein du groupe et son impact sur les préjugés et la reconnaissance des visages. Mon objectif n'était pas de fournir une conceptualisation encadrée, universelle et définie de ce qu'est un groupe ethnique, et je ne pense pas que cela soit possible ou défendable. Il s'agissait plutôt de comprendre l'effet de la perception de l'appartenance à un groupe ethnique sur les processus sociaux et de mémoire. Un objectif sous-jacent était de mettre en évidence l'existence d'une hétérogénéité au sein du groupe et de mesurer ses conséquences sur le BRE. Là encore, il s'agissait de comprendre ce qui peut apparaître comme un processus cognitif, tel que la perception de caractéristiques physiques (couleur de peau, coupe de cheveux, etc.), dans son contexte social et de comprendre comment ces dimensions interagissent.

Résumé des principaux résultats

Dans deux expériences, j'ai pu répliquer l'existence du BRE sur une population franco-européenne vis-à-vis des personnes d'origine nord-africaine et africaine, bien que les tailles d'effet soient relativement faibles.

Dans la première expérience, je n'ai pas pu trouver un schéma clair de l'effet du contact social, soit manipulé, soit mesuré en termes d'histoire d'interactions personnelle des participants, sur la performance de reconnaissance. Il n'a donc pas été possible de confirmer l'hypothèse selon laquelle le BRE est fonction des modèles d'interaction sociale. De même, les variables de préjugés ethniques et d'anxiété d'interaction n'ont pas été évaluées comme ayant un impact significatif sur la performance de reconnaissance en interaction avec le contact social. Ainsi, les hypothèses concernant l'impact des composantes sociales sur le BRE n'ont pas pu être validées. Dans la même expérience, j'ai étudié les différences potentielles dans les stratégies visuelles employées pendant l'encodage et la reconnaissance des visages. J'ai testé si de telles différences pouvaient être trouvées à travers les groupes ethniques des stimuli et en fonction du contact social, qu'il soit à nouveau manipulé ou mesuré en termes d'histoire d'interactions individuelle. La première hypothèse, c'est-à-dire concernant les différences entre les ethnies, n'a pas pu être confirmée. Les participants Européens n'ont pas utilisé un balayage visuel différent pour les groupes de stimuli Nord-Africains et Auropéens. Cependant, il a été possible de montrer les effets du contact social, mesuré et manipulé, sur les stratégies visuelles. En particulier, il a été montré que les différents modes de contact social étudiés (quantité, qualité et évitement) ont un impact significatif sur la façon dont un visage est balayé visuellement. L'interprétation de ces résultats doit être faite avec prudence car ces effets se sont avérés indépendants du groupe ethnique des stimuli. Un niveau élevé de contact auto-déclaré avec des individus Nord-Africains était associé à une plus grande concentration visuelle sur la partie supérieure du visage. Inversement, les comportements d'évitement du contact étaient associés à une concentration plus faible sur le visage inférieur. Ensuite, un impact de la manipulation du contact a également été trouvé, car les stimuli perçus avec contact étaient traités différemment, visuellement. Plus précisément, les stimuli du visage encodés pendant une interaction sociale recueillaient moins de fixations que les stimuli encodés sans interaction sociale.

J'ai ensuite réalisé une revue systématique sur le thème du biais de phénotypicalité, et plus particulièrement sur l'impact de l'ethnicité perçue sur l'activation des préjugés. J'ai pu établir plusieurs choses. Premièrement, la littérature scientifique sur le biais de phénotypicalité reste relativement inexplorée et a été étudiée principalement aux Etats-Unis en utilisant des

stimuli faciaux d'hommes. Deuxièmement, la multiplicité des méthodologies rend difficile l'établissement d'un constat clair ou l'identification de facteurs qui permettraient de tirer des conclusions sur la force de l'effet de la typicité ethnique perçue sur l'activation des préjugés ethniques. Toutefois, ce phénomène a été reproduit à différentes occasions, par le biais de différentes mesures et dans différents contextes. Cela peut fournir certaines preuves de l'importance de ce biais. Cette revue systématique a surtout soulevé l'importance de considérer l'occurrence de la discrimination ethnique s'appliquant au groupe ethnique de manière homogène. Elle établit la notion de traitement différentiel au sein des groupes de stimulus, où la typicité ethnique perçue influence la force d'activation des préjugés de groupe. Enfin, cette revue systématique a permis d'identifier une série de méthodologies pour manipuler la typicité ethnique perçue qui pourraient être utilisées pour des études ultérieures, ce qui s'est avéré utile dans mon propre cas.

Dans la dernière expérience de cette thèse, j'ai évalué l'impact de la typicité ethnique perçue sur le BRE tout en considérant les interactions potentielles avec les modèles de contact social et les préjugés. J'ai pu identifier un effet de la typicité ethnique perçue, mais uniquement pour la condition expérimentale contrastant les stimuli Européens et Nord-africains. De plus, cet effet a montré une direction opposée à celle attendue, c'est-à-dire une meilleure performance de reconnaissance pour les individus hautement typiques par rapport aux individus perçus comme moins typiques de leur groupe ethnique. Enfin, je n'ai pas trouvé d'effets d'interaction entre les variables de contact social et de préjugés ethniques et les variations de la typicité ethnique perçue.

Conclusions

Le travail présenté dans cette thèse avait de nombreux objectifs. Les deux objectifs majeurs étaient d'évaluer de manière approfondie à la fois l'impact de l'interaction sociale inter-groupe et la variabilité intra-groupe sur la reconnaissance des visages. Les résultats obtenus n'ont pas permis de conclure clairement sur l'impact de l'une ou l'autre de ces variables. Cependant, quelques pistes intéressantes semblent avoir émergé, notamment sur la manipulation du contact social mis en place dans la première expérience et son impact sur les stratégies de balayage visuel des visages. Comme mentionné précédemment, il est possible que l'aspect social du contact ne joue pas un rôle majeur dans le développement du BRE ou que son importance soit définie par d'autres éléments comme une période critique (McKone et al., 2019). Cela ne change rien à l'importance de poursuivre l'étude de ce biais et de comprendre ses implications sociales et cognitives. L'incapacité ou la difficulté à reconnaître quelqu'un a un impact important sur les individus à différents niveaux. Comme présenté dans l'introduction

générale, ce biais de reconnaissance continue d'avoir de nombreuses conséquences dans le cadre judiciaire, mettant en péril la liberté des individus. Mais plus généralement, ce biais de reconnaissance a également un impact sur nos relations sociales intergroupes. Il est donc essentiel d'approfondir l'ensemble des éléments qui entourent le BRE. Enfin, il semble que des liens puissent être établis avec d'autres types de biais attitudinaux et que des éléments tels que la variabilité intra-groupe ne doivent pas être sous-estimés. Le BRE est un phénomène complexe dont les implications sont diverses et dont les approches peuvent être cognitives, sociales et développementales. Cette thèse a apporté une contribution modeste mais significative à la compréhension du BRE.

List of Appendices

Appendix A

Box A.1

STAI-Y, Spielberger, et al., 1983

STAI- Y FORM B in French

Consigne : Un certain nombre de phrases que l'on utilise pour se décrire sont données ci-dessous. Lisez chaque phrase puis entourez, parmi les 4 points « Non » « Plutôt non », « Plutôt oui » et « Oui », celui qui correspond le mieux à ce que vous ressentez A l'INSTANT, JUSTE EN CE MOMENT.

Il n'y a pas de bonnes ou de mauvaises réponses. Ne passez pas trop de temps sur l'une ou l'autre de ces propositions et indiquez la réponses qui décrit le mieux vos sentiments ACTUELS.

1/ Je me sens calme.

Non - Plutôt non - Plutôt oui - Oui

2/ Je me sens en sécurité, sans inquiétude, en sureté.

Non - Plutôt non - Plutôt oui - Oui

3/ Je suis tendu.e, crispé.e.

Non - Plutôt non - Plutôt oui - Oui

4/ Je me sens surmené.e.

Non - Plutôt non - Plutôt oui - Oui

5/ Je me sens tranquille, bien dans ma peau.

Non - Plutôt non - Plutôt oui - Oui

6/ Je me sens ému.e, bouleversé.e, contrarié.e.

Non - Plutôt non - Plutôt oui - Oui

7/ L'idée de malheurs éventuels me tracasse en ce moment.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

8/Je me sens content.e.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

9/ Je me sens effrayé.e.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

10/ Je me sens à mon aise (je me sens bien).

Non   -   Plutôt non   -   Plutôt oui   -   Oui

11/ Je sens que j'ai confiance en moi.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

12/ Je me sens nerveux.se, irritable.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

13/ J'ai la frousse, la trouille (j'ai peur).

Non   -   Plutôt non   -   Plutôt oui   -   Oui

14/ Je me sens indécis.e.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

15/ Je suis décontracté.e, détendu.e.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

16/ Je suis satisfait.e.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

17/ Je suis inquiet.e, soucieux.se.

Non   -   Plutôt non   -   Plutôt oui   -   Oui

18/ Je ne sais plus où j'en suis, je me sens déconcerté.e, dérouté.e.

Non - Plutôt non - Plutôt oui - Oui

19/ Je me sens solide, posé.e, pondéré.e, réfléchi.e.

Non - Plutôt non - Plutôt oui - Oui

20/ Je me sens de bonne humeur, aimable.

Non - Plutôt non - Plutôt oui - Oui

Appendix B

Prejudice and contact scale testing

This appendix details the process followed for the creation, validation and testing of the two tools for measuring social contact and prejudice. The reader will find a rationale, the method, the statistical analyses as well as the discussion of the analyses below.

Overview of the creation of atittudes and contact scales

The main objective was to propose and test the internal structure of two scales to assess patterns of social interaction and prejudice towards North-Africans, which could, with minor modifications, be adapted to other ethnic groups. This process was divided in two parts : a first part that refers to the Exploratory Factor Analysis (EFA) and another one that refers to the Confirmatory Factor Analysis (CFA). Since they were not conducted on the same participants and they don't include the same statistical analysis, I am presenting them separately.

Some of the origins of the OGRB could be in social components such as social interaction patterns and prejudice. Several scales exist for these individual components. First, a variety of intergroup social interaction scales can be found in the OGRB literature (e.g., Hancock & Rhodes, 2008) but also in the contact theory literature (Barlow et al., 2012; Islam & Hewstone, 1993; Voici & Hewstone, 2003). Some focus more on the quality of interactions (e.g., Pettigrew, 1997), and others on the quantity of interactions (Hancock & Rhodes, 2008). More recent scales includes items that focus on a difference between positive and negative contact (Barlow et al., 2009; Dhont & Van Hiel, 2009; Graf et al., 2014; Paolini et al., 2010). These scales vary from a few items to several dozen items grouped into subcategories.

However, these scales have a number of limitations. Firstly, they are mainly in English and are generally oriented towards a particular population/group (most scales concern the intergroup relationship between white and black individuals). Secondly, they have not been systematically evaluated in terms of reliability and the construction and validation of the different items are sometimes unclear. Finally, these scales rarely include items that evaluate negative contact, or social contact avoidance behaviours, both components of contact that, as noted in Chapter 1, may be particularly important (Barlow et al., 2012; Dixon et al., 2005).

With respect to 'racial'/ethnic prejudice scales, there is also a significant body of work that has proposed scales to assess prejudice toward a given group. These are self-report and

explicit measures of bias, but they come in different forms depending on whether they measure subtle (Henry and Sears, 2002), blatant prejudice, or both (Meertens & Pettigrew, 1997). Here again, most of the work is written in English and concerns the evaluation of negative attitudes towards individuals of African origin. There are, however, French scales, notably that of Dambrun and Guimond (2001), which concerns the evaluation of generalized prejudice towards individuals of North-African origin. However, norms regarding attitudes change with the temporal and cultural context. Therefore, existing scales in the literature may not be suitable for assessing prejudice in a French context in the 2020s.

Thus, it appears necessary to propose two new scales, one dealing with social interaction habits and the second with prejudice. These two scales can be created from the merging and adaptation of already existing items but also by adding original ones. The creation and validation of both questionnaires needs to be carried out in several stages. On a first sample of participants, one can perform an exploratory factor analysis (EFA). Then, after an initial factor structure has been identified, including the selection and exclusion of certain items, a confirmatory factor analysis (CFA) can be conducted on another sample of participants.

Exploratory Factor Analysis (EFA)

Method

Participants

A total of 513 participants completed the attitude and contact scales. 286 participants had to be dropped from the final sample for two reasons : 251 of them didn't complete the questionnaire[18], and 35 were not identified as belonging to the group of interest (European). The final sample consisted of 227 participants (M = 24.6 years, SD = 8.51), including 189 women, 34 men and 4 unidentified gender individuals.

Scale development

In order to construct the scale of social contact habits towards North Africans, a number of elements were taken into account. Based on the literature, I decided to orient my items around three main categories: quantity, quality and avoidance of contact. Particular attention was paid

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[18] Participants who did not complete the entire questionnaire did not (1) answer all items of both scales, and (2) fill in their ethnic group. This second part was particularly important for the validation of these scales, one of the criteria of which was that participants should be European.

to the quality of contact in order to include elements on negative contact. For the categories of contact quantity and quality, pre-existing items in the contact scales literature were reused and sometimes adapted and in particular from the work of Hancock and Rhodes (2008). For the avoidance of contact, items are original but some have been created based on the work of Durrheim et al. (unpublished manuscript). Responses to the questions for the contact avoidance items were made on a 5-point scale ranging from "Strongly disagree" to "Strongly agree". The items assessing quantity of contact also had a 5-point scale ranging from "Strongly disagree" to "Strongly agree", except for item Q4-1 which had to be adapted to a scale ranging from "None" to "All". Finally, the items on contact quality were all on a 5-point scale ranging from "Never" to "All the time".

For the construction of the items on attitudes towards people of North-African origin, I built the scale two of the three dimensions of attitudes. The first was based on the conative dimension and gathered items on the adhesion to discriminatory behaviour observed in France towards individuals of North-African origin (e.g., access to accommodation, employability, and leisure). The second was based on an affective dimension and gathered notably items on appreciation of North-African culture (e.g. values, religion, language and cuisine), and of North-African individuals in general. As with the contact scale, I also based some of the items on existing literature. In particular, certain items were devised based on the work of McConahay, et al. (1981), Pettigrew and Meertens' (1995) subtle prejudice scale, Henry and Sears' (2002) symbolic racism scale, Haddock, et al. (1993) attitudinal measure and Dambrun and Guimond's (2001) generalized prejudice scale. Responses to all items were made on a 5-point scale from "Strongly disagree" to "Strongly agree".

All items and response scale dimensions were proposed during a team meeting of the members of the ANR project from which this thesis originated. At the end of this first stage, the items were submitted to a team of 10 doctoral and post-doctoral researchers for evaluation. This step allowed me to check whether each item was easily understandable, the response scale used, and the global coherence. Particular attention was paid to the questions on prejudice, which generally generate discomfort on answering. Some items were thus re-adapted and an attempt was made, as far as possible, to propose Likert scales of a similar type, particularly within the subscales. Following this first pre-test it was also decided to add to the instructions for completing each item a description of what we were referring to when using the term "person of North-African origin". The final version had 52 items, including 24 for the contact scale and

28 for the attitude scale. The contact scale had 10 items on contact avoidance, 6 on the quantity of contact and 8 on the quality of contact. The attitude scale had 11 items on adhesion to discriminatory behaviour, 11 items on appreciation of North-Afircan Culture and 6 on the affective dimension.

Scale diffusion and protocol

The scale was distributed online to Facebook groups of students. A post with a short explanation of the task was posted on Facebook with an indication of the average completion time and of the research context in question. All scale items were completed via Qualtrics (Qualtrics, Provo, UT).

Participants were able to complete the questionnaire on their own device (computer, tablet or phone) and from any location as long as they had an internet connection. Once the participant had clicked on the Qualtrics link, they were presented with a consent form where a range of information was provided. This included the average time taken to complete the questionnaire (approximately 20 minutes), the outline/objectives of the questionnaire, and the background to the research (e.g. funding, principal investigators, etc.). The participant was informed that completion of the questionnaire was anonymous, that they could stop at any time and that no compensation would be given for their participation.

Once the consent form was signed, a first block of questions was presented to the participants. Each scale was divided into two subsections; the contact scale was divided into a block on contact avoidance behaviour and a block on quantity and quality of interactions. Similarly, the attitude scale was divided into a subsection on 'discriminatory' prejudice, appreciation of North-African culture and another on 'affective' attitudes. In order to avoid an order effect, these blocks of questions were presented randomly. The questions within each block were also randomised. Before each block of questions an appropriate instruction was given indicating the response scale. Associated with each instruction was also the definition of an individual of North-African origin as follows: "*Note: The term 'person of Maghrebi origin' includes individuals born in the Maghreb or born outside the Maghreb but of direct Maghrebi descent (parents, grandparents, great-grandparents etc.). The Maghreb includes Algeria, Libya, Morocco, Mauritania and Tunisia.''*

Once the scale blocks were completed, a final block of demographic questions was presented, including a question on gender, age and ethnic group. For the latter, two pieces of information were requested, the first being the geographical area of birth of each of the four

grandparents and the second a question on phototype, taken from Fitzgerald's (1975) work on skin reactivity to the sun. Together, these items provide a general idea of the participant's ethnic group. This approach was considered by the ANR team and validated by the Toulouse Ethics committee in order to respect the laws in force on recording ethnicity in France.

Finally, participants were offered a short debriefing text on the value of validating a scale of prejudice and habits of social interaction with North-African individuals in France and contact information was left for any questions or requests related to this protocol.

Results

The aim of an EFA is to reveal a latent structure of the set of response data to the questionnaire. The interest is to identify a set of underlying factors or dimensions in a single scale. Exploratory factor analysis is recognised as being appropriate for testing scales under construction (Hurley et al., 1997).

The EFAs were conducted using the statistical software jamovi (The Jamovi Project, n.d.), Version 1.6. For both scales, the method used was based on a minimum residuals extraction with an 'oblimin' rotation. This rotation method is recommended in the case of suspected correlations between factors and non-normal item distributions (Durand, 2003). The number of factors was determined through parallel analysis (Horn, 1965).

Prejudice scale

A first EFA with all 28 prejudice scale items was carried out. The Barlett's test of sphericity was significant ($p < .001$), which confirms that all items can be considered as independent from each other. The KMO measure of sampling adequacy was also satisfactory (= 0.87). Two of the assumptions necessary to carry out an EFA were therefore verified.

Five factors were extracted from this first analysis (see Table B.1), the inter-factor correlation matrix presented correlations higher than 0.3, justifying the use of an oblimin rotation.

Two items (Q1-8 and Q1-17) did not saturate sufficiently (<.3) and were therefore not retained in the final model. These two items were each associated with another item whose direction was reversed. As a result, their respective twin items (Q1-9 and Q1-18) were also discarded in order to respect the balance of the items' valence.

Table B.1

Factor loading for a 5-factor solution on the Prejudice scale

	Factor					Uniqueness
	1	**2**	**3**	**4**	**5**	
Q1-1	0.806					0.278
Q1-7	0.743					0.379
Q1-9	0.732					0.427
Q1-2	0.631					0.583
Q1-18	0.573					0.640
Q1-19	0.566					0.731
Q5-6	0.310					0.516
Q1-8						0.932
Q1-17						0.930
Q1-3		0.741				0.363
Q1-5		0.734				0.428
Q1-10		0.671				0.408
Q1-11		0.604				0.463
Q1-6		0.514				0.659
Q1-4		0.428				0.703
Q1-22			0.750			0.360
Q1-15			0.558			0.562
Q1-16			0.544			0.729
Q1-13			0.520			0.673
Q1-12			0.499			0.726
Q1-14			0.414			0.654
Q5-2				0.918		0.175
Q5-3				0.611		0.597
Q5-1				0.495		0.507
Q5-5				0.421		0.538
Q5-4				0.307		0.706
Q1-20					0.825	0.341
Q1-21					0.529	0.570

Note. 'Minimum residual' extraction method was used in combination with an 'oblimin' rotation. Both items Q1-17 and Q1-8 did not saturate over 0.3 with any factor.

The overall proportion of variance explained by these five factors is 44.4%. The first three factors represented percentages of variance explained around 10%, factor 4 representsed 7% and factor 5 represented only 4.5%. Given the low variance explained by this last factor,

but also considering the general meaning of this model with two isolated items, it appeared that it was not necessary to keep those items in the final version of the model.

Catell's scree plot showed 3 factors, however in view of the variance explained by the fourth factor (>7%) and the important number of items in it, I decided to keep this factor in the final model. Thus, I discarded 6 items for the final model, items Q1-8, Q1-9, Q1-17, Q1-18, Q1-20 and Q1-21.

The final model contained 4 factors. The first factor consisted of five items and can be called '*indirect expression of prejudice*' since each item refers to the attitudes of a third person (e.g. Q1-19: "I think that what should matter for the owner of a flat looking for tenants is the financial guarantees of the applicant and not his or her ethnic origin"). However, item Q5-6 did not seem to correspond to this grouping since it is based more on a notion of affective attitude ("I feel threatened by people of North-African origin"). It will be necessary to verify its appropriateness in the final model assessed in the CFA. The second factor consisted of six items and can be called '*direct expression of prejudice*' as it included items that directly measure the discriminatory attitudes of the participants (e.g., Q1-4: "I think that employment discrimination against people of North-African origin is overestimated.) Factor 3 also included six items and can be called '*affect towards North-African culture*' since all items mentioned Maghrebi culture such as values, religion or cuisine (e.g., Q1-22 "I appreciate Maghrebi culture (Arabic language, gastronomy, literature, visual art, music, dance, heritage, painting, etc."). Finally, the fourth factor consisted of five items and can be called '*general affect towards North-Africans*' since it gathered items dealing with an affective evaluation of North-African individuals (e.g. "I feel confident with people of North-African origin").

In order to verify the relevance of the tool through the study of internal consistency, the reliability of each sub-scale was assessed using Macdonald's Omega (ω). The items of the '*indirect expression of prejudice*' component had a ω = .80, those of the '*direct expression of prejudice*' component had a ω = .84, those of the '*affect towards North-African culture*' component had a ω = .77 and finally those of the '*general affect towards North-African*' component had a ω = .79. The results of the Macdonald's omega indices are considered satisfactory.

Contact scale

An EFA with all 24 items on contact was carried out. Bartlett's test of sphericity was significant ($p < .001$), which confirmed that all items can be considered as independent from each other. The KMO measure of sampling adequacy was also satisfactory (KMO=0.86), suggesting an excellent sampling adequation. The two assumptions necessary to carry out an EFA are therefore verified.

Four factors were extracted from this first analysis (see Table B.2), the inter-factor correlation matrix presented correlations higher than 0.3, justifying the use of an oblimin rotation. One item (Q3-10) saturated in two factors (factor 2 and 4) and with a very small saturation (=.3) and were therefore not retained in the final model.

Table B.2.

Factor loading for a 5-factor solution on the Contact scale

	Factor				
	1	**2**	**3**	**4**	**Uniqueness**
Q4-15	0.783				0.406
Q4-13	0.781				0.369
Q4-12	0.721				0.490
Q4-6	0.710				0.458
Q4-8	0.699				0.412
Q4-9	0.699				0.460
Q4-11	0.616				0.494
Q4-1	0.594				0.593
Q4-14	0.389				0.814
Q4-16	0.328				0.889
Q3-3		0.786			0.332
Q3-6		0.738			0.436
Q3-4		0.725			0.447
Q3-2		0.693			0.554
Q3-5		0.656			0.522
Q3-1		0.604			0.488
Q4-7			0.814		0.344
Q4-5			0.767		0.394
Q4-10			0.701		0.438
Q4-4			0.684		0.549
Q3-9				0.791	0.336
Q3-7				0.745	0.414
Q3-8				0.693	0.474
Q3-10		0.305		0.344	0.688

Note. 'Minimum residual' extraction method was used in combination with an 'oblimin' rotation.
The item Q3-10 saturates with two factors to a low level (>0.35) and might be disregarded.

The overall proportion of variance explained by these four factors is 50.8%. The first factor represented 17.96% of explained variance, the second one around 14%, and the two last

factors around 9%. The scree plot supported that 4 factors can be retained, confirming previous statement.

One item only was disregarded for the final model (Q3-10). The final model contains 4 factors. The first factor consisted of 10 items and can be called '*positive contact*' since each item refers to quantity or positive quality of contact (e.g. Q4-6: " In what proportion do you have friendly experiences with people of North-African origin?"). The second factor consisted of six items and can be called '*physical avoidance*' as it included items that directly measure the behaviour of physical avoidance towards North-African individuals (e.g. Q3-4: " When I chose my accommodation (flat, room, house, etc.), I avoided areas with a strong North-African presence".) Factor 3 included four items and can be called '*negative contact*' since it included all items refering to negative quality of contact with North-African individuals (e.g. Q4-4 "To what extent do you feel devalued by people of North African origin?"). Finally, the fourth factor gathered three items and can be called '*conversation subject avoidance*' since it gathered the items referring to avoidance behaviour of discussing about specific subject (e.g. Q3-7: " In general, when I talk to a person of North-African origin, I prefer to avoid talking about international conflicts").

In order to verify the relevance of the tool through the study of internal consistency, the reliability of each sub-scale was assessed using MacDonalds Omega (ω). The items of the '*positive contact*' component had a $\omega = .89$, those of the 'physical avoidance' component had a $\omega = .87$, those of the 'negative contact' component had a $\omega = .84$ and finally those of the 'conversation subject avoidance' component had a $\omega = .82$. The results of the Macdonald's omega calculations are considered satisfactory.

Discussion

This exploratory factor analysis identified an initial structure for the two scales. The attitude scale, after the EFA, comprises 22 items divided into 4 factors: *'indirect expression of prejudice, 'direct expression of prejudice', 'affect towards North-African culture'* and *'general affect towards North-Africans'*. The contact scale consists of 23 items for which the EFA also revealed 4 factors: *'positive contact', 'physical avoidance', 'negative contact'* and *'conversation subject avoidance'*. These two scales seem to present a relatively coherent and reliable structure,

it is however necessary to continue with a second analysis (the Confirmatory Factor Analysis) on another sample that will confirm the latent structure of these two scales.

CFA

CFA was conducted on data collected during two separate studies using the contact and prejudice scales. The first data collection was from the first study of this thesis (presented in Chapter 2) and the second data collection was from participants of second study and its pretests (presented in Chapter 4). The details of participation in these two data collection exercises are outlined in the participants section. For the rest of the analyses, the data were combined and are considered as a single dataset.

Method

Participants

In the first data collection (Chapter 2), a total of 126 participants completed the contact and prejudice scales. 17 participants had to be excluded from the analyses because their ethnic group did not correspond to that of the Europeans, and 13 participants because of software malfunction. For this first collection, 96 participants were retained.

In the second data collection, a total of 209 participants completed both scales. 86 participants had to be excluded from the analyses for two reasons: either the participant did not complete the questionnaire to the end[19] ($N = 68$), or the ethnic group filled in was not that of the population of interest ($N = 18$). For this collection, 122 participants were retained.

In total, these two data collections constituted a final sample of 218 participants ($M = 27.8$, $SD = 13$), including 190 women, 23 men and 4 whose gender was not identified.

Material

The two scales in the CFA corresponded to the those constituted by the items selected after the first factor analysis (EFA) explained above. A total of 55 items were presented; the attitude scale comprising 22 items and the contact scale 23 items. The same block structure used previously was retained to present the items of both scales.

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[19] As before, when the participant did not complete the entire questionnaire, and for this particular collection, the entire task (see Chapter 6), there was (1) not all of the response data for both scales, (2) the participant's ethnic group data which does not identify the main inclusion criterion for this sample.

Protocol

For both data collection exercises, the completion of the questionnaire was done on a digital medium (tablet, computer or phone) on the Qualtrics software. However, in the first data collection, the two scales were completed in the experimental room in the presence of the experimenter (see protocol Chapter 2) whereas for the second data collection the completion was carried out from any location, without the experimenter, as long as the participant had a sufficient internet connection (see protocol Chapter 4).

In both cases, the completion of the questionnaire was the final stage of the study (following a phase of encoding and recognition of European and North-African faces). The presentation of the items was carried out in the same way in both surveys, with the same instructions and response modalities. As outlined in the EFA earlier this part, the items were presented in blocks, presented randomly, within which the items themselves were presented randomly, in order to avoid any order effect. Before each block an instruction was displayed presenting the modalities of answers and a definition of what was included in the notion of individuals of North-African origin. The questionnaire always ended with the demographic questions including items on the country of birth of grandparents and phototype (assessing the participant's ethnic group).

A debriefing was always offered at the end of the experiment, either directly by the experimenter or in the form of a short explanatory text.

Results

The confirmatory factor analysis (CFA) makes it possible to verify and validate the construct of the two scales suggested by the EFA. The latent factors identified previously were tested again with a new sample in a rigorous manner. Based on the data put forward in the EFA, it was possible to verify how the new data correspond to the predefined structure. The CFA also assessed how the different factors are acting together (through correlation analysis) and whether this is theoretically supported. As for the EFA, the analyses were conducted on the statistical software jamovi,Version 1.6.

Prejudice scale

The four factors determined by the EFA (*'Indirect expression of prejudice'*; *'Direct expression of prejudice'*; *'Affection towards North-African culture'*; *'General affection towards North-African culture'*) were entered into the parameters of the statistical analysis with the

corresponding items. The parameters included a full information maximum likelihood missing value method and with the constraints set at factorial variances equal to one. The fit of the model was assessed by the Chi-square statistic, which, when low, indicates that the model fits the data well. This measure is, however, sensitive to the sample size (Brown, 2015), which is why for large samples a consistently high and significant value is observed. It is possible to use the ratio index χ^2/df (Marsh & Hau, 1996). This first element did not seem to indicate a satisfactory fit of the data $\chi^2(203) = 545$, p<.001, χ^2/ddl = 2.69. It was also possible to assess the fit of the data to the model with fit indices such as the Comparative Fit Index (CIF), the Tucker Lewis Index (TLI) and the Root Mean Square Error of Approximation (RMSEA).

Table B.3.

Model fitting results of the EFA structure for the CFA on the prejudice scale

			RMSEA 90% CI			
CFI	TLI	RMSEA	Lower	Upper	AIC	BIC
0.801	0.774	0.0879	0.0790	0.0968	12222	12466

Note. CFI and TLI must be >.0.9 to be considered as satisfactory. The RMSEA
must be between 0.05 and 0.08 to be considered as satisfactory.

Here again, the fitting indices did not show a satisfactory fit to the model (see Table B.3). The CFI and TLI are considered satisfactory when they reach a value > 0.9. Similarly the RMSEA remained too high with an ideal value between 0.05 and 0.08. However, the factor loadings and covariance estimates show quite satisfactory Z-statistics and p-values, indicating a non-zero contribution to the models. In other words, none of the items needed to be removed from a factor as each makes a reasonable contribution.

In order to best fit the data to the model, it is possible to make post-hoc adjustments. For this purpose, modification indices (MI) of factor saturation were an interesting indicator to consider (Table B.4).

Table B.4.

Modification Indices of factor saturation for the CFA on the Prejudice scale

	Indirect expression of prejudice	Direct expression of prejudice	Affect towards north-african culture	General affect towards North African
Q1-1		0.657	3.789	6.00395
Q1-2		0.107	5.022	6.01769
Q1-7		0.678	1.453	4.68371
Q1-19		0.167	2.582	6.70020
Q5-6		9.373	10.378	26.11153
Q1-3	3.0528		1.131	0.54809
Q1-5	7.0876		3.600	0.83884
Q1-10	1.8118		6.529	2.34625
Q1-11	8.8446		2.533	0.35112
Q1-4	4.3095		1.525	0.41025
Q1-6	3.1604		14.729	0.45849
Q1-22	0.0847	0.638		0.00791
Q1-15	2.3104	13.383		0.42214
Q1-16	0.2234	0.244		1.03002
Q1-13	6.3989	4.878		3.97844
Q1-12	2.1590	6.187		2.91078
Q1-14	5.9597	4.862		4.24141
Q5-1	0.2752	0.397	0.801	
Q5-4	12.8901	8.563	0.151	
Q5-5	27.2942	6.610	2.860	
Q5-2	8.2026	9.686	0.300	
Q5-3	10.4940	0.884	0.609	

Note. Modification Indices in red represents the highest value for each factors.

Table B.4 highlighted two items with relatively high MI (>25). These were the two items Q5-5 and Q5-6. Although Q5-5 had a slightly higher MI (27.29), it is interesting to rethink the position of Q5-6 which, as noted by the EFA, did not appear to be congruent in term of global sense with the other items in its factor. Indeed, the EFA highlighted that this item seemed to contribute more to factor 1 *'Indirect expression of prejudice'* or, its original meaning ('I feel threatened by people of North-African origin') seemed to be closer to factor 4 *'General affection towards North-Africans'*. In this case, it is preferable to focus on the item sense rather than

making a choice solely on the magnitude of the modification index. Consequently, item Q5-6 will be added to the model as a contributor to factor 4.

After modification of the contribution of this item, a new confirmatory analysis was launched. Although a slight improvement appeared, the fit indices of the model were still unsatisfactory $\chi2(203) = 521$, p<.001, $\chi2/ddl = 2.57$, CFI = .82, TLI =.79, RMSEA =.85. It was therefore necessary to pursue possible post-hoc modifications to obtain a satisfactory model.

The same process can be used until a model with a more satisfactory overall fit is obtained. After moving 3 more items, I reached a more appropriate overall level with $\chi2(203) = 460$, p<.001, $\chi2/ddl = 2.26$. The items of the factor *'General affect towards North-Africans'* Q5-1, Q5-2 and Q5-3 were incorporated into factor 3 *'Affect towards North-African culture'*. The model fit indices were more satisfactory, with RMSEA showing a good fit index, but the CFI and TLI remained slightly below the threshold considered satisfactory (see Table B.5). The results of this last CFA still show a better fit to the data than the first model, with a lower AIC.

Table B.5.

Model fitting results of the CFA after modification of factors

			RMSEA 90% CI		
CFI	TLI	RMSEA	Lower	Upper	AIC
0.851	0.830	0.0761	0.0669	0.0854	12137

It was preferable not to make any additional post-hoc modifications in order to maintain a general structure, admittedly imperfect, which I felt was preferable to shifting again items from one latent factor to another which could compromise the general meaning of my different factors. Therefore, three items were included in the factor that initially included questions about affect towards North-African culture. The implication of these additions on the meaning of the factor will be discussed below.

This confirmatory analysis for the prejudice scale did not support the structure identified by the EFA. This scale is still divided into 4 factors, but with a modification of the items within the factors, which final structure is detailed at the end of this section of the analysis. In order to

verify the relevance of the tool through the study of internal consistency, the reliability of each sub-scale was assessed using MacDonald's Omega. The items of the *'indirect expression of prejudice'* component had a ω = .76, those of the *'direct expression of prejudice'* component had a ω = .83, those of the '*affect towards North-African culture*' component had a ω = .81 and finally those of the '*general affect towards North-African*' component had a ω = .79. The results of the Macdonald's omega calculations are considered satisfactory.

Contact scale

The four factors determined by the EFA (*'Positive contact'*; *'Physical avoidance'*; *'Negative contact'*; *'Conversation subject avoidance'*) were entered into the parameters of the statistical analysis with the corresponding items. The parameters included a full information maximum likelihood missing value method and with the constraints set at factorial variances equal to one.

Again, the values of $\chi 2$ and its ratio to degrees of freedom were not completely satisfactory although close to the desired value, $\chi 2(224) = 511$, p<.001, $\chi 2/ddl = 2.28$. Similarly, the indicators of model fit were not all completely within the satisfaction thresholds (Table B.6). As with the prejudice scale, the factor loadings and covariance estimates show acceptable Z-statistics and p-values, demonstrating a reasonable contribution of each item within the factors.

Table B.6.

Model fitting results of the EFA structure for the CFA on the prejudice scale

| | | | RMSEA 90% CI | | |
CFI	TLI	RMSEA	Lower	Upper	AIC
0.889	0.875	0.0767	0.0679	0.0855	12352

In contrast to the previous analysis, it did not seem advisable to make post-hoc modifications to the positioning of items within the factors. The Modification Indices of the different items did not have high values presenting one of the items as potentially more adequate in another factor. Furthermore, the items designated with the highest MI values were not in terms of meaning more suitable in the recommended factors (e.g. Q4-11 in factor 2 or 3 instead of the first one). Therefore, no post-hoc modifications were made to the initial model. This scale was still divided into 4 factors, with no modification from the EFA structure of the items within the factors. Its final structure is described below. In order to verify the relevance of the tool through the study of internal consistency, the reliability of each sub-scale was assessed using the Macdonalds Omega. The items of the *'positive contact'* component had a $\omega = .89$, those of the *'physical avoidance'* component had a $\omega = .90$, those of the *'negative contact'* component had a $\omega = .85$ and finally those of the *'subject conversation avoidance'* component had a $\omega = .83$. The results of the Macdonald's omega set are considered satisfactory.

Discussion

The confirmatory factor analyses conducted on the Prejudice scale and the Contact scale validated the initial structure proposed by the EFA, with a number of limitations. The overall structure of the Prejudice scale had to be revised in order to change the allocation of some items to factors. In total, 4 items were moved from one factor to another, significantly improving the fit of the data to the model. For the contact scale, no modifications were necessary, however the fit indices were not fully satisfactory.

Two scales with 4 latent factors each were obtained, with satisfactory reliability for each of these sub-scales. Thus, I believe that I had obtained satisfactory although imperfect tools. The final scales are presented below.

General Discussion

The aim of this part was to create and test a scale for measuring prejudices and a scale for measuring patterns of social interaction towards people of North African origin. After a literature review, it appeared necessary to propose a set of items characterising the different dimensions of the two measures. For the prejudice scale, a set of items on the adherence to indirect and direct discriminatory behaviours was proposed, another set of items dealing more with the appreciation of the Maghrebi culture and finally a last set dealing with a rather affective

dimension of Maghrebi people in general. For the contact scale, a set of items assessing the quantity of contact was proposed, followed by a set of items assessing the quality of contact (positive and negative) and finally a set of items assessing contact avoidance (physical and interactional). The first step consisted of an initial evaluation of the internal structure of the scale with an exploratory factor analysis. This revealed, after the removal of some items, two structures with 4 latent factors for each scale.

A second step consisted in validating this structure by a confirmatory factor analysis. For the Contact scale, the structure put forward by the EFA was validated. The distribution of items between each factor reflects the original construct relatively faithfully and is consistent with the structures put forward in the literature. Thus, we find 2 factors grouping items on the quantity and quality of contact distributed on their valence 'positive contact' (10 items) and 'negative contact' (4 items), and on the other hand we find 2 factors on the avoidance of contact, one dealing specifically with 'physical avoidance' (6 items) and the second on 'avoidance of the subject of conversation' (3 items). The reliability within each factor is very good, and the fit indices show an acceptable model. With regard to the prejudice scale, the initial structure proposed by the EFA could not be verified. This scale required more attention in the EFA with more items to be discarded, but also more items to be moved from one factor to another in the CFA. After switching the contribution of some specific items between latent factors, we find a non-optimal but satisfactory structure. The four original latent factors can be retained. However, the significance of two of them in particular deserves to be reconsidered. Indeed, factor 3, initially named *'affect towards North-African culture'* now includes 3 new items that are more oriented towards a general affective evaluation of North-Africans. The 9 items of this factor are therefore mainly oriented toward culture, but another common element appears: positive affect. Conversely, factor 4, originally named *'general affect towards North-Africans',* is now composed of only 3 items, and the meaning, still related to general affect towards North-Africans, is now composed of only negative affect items. Therefore, two new designations could be considered for factors 3 and 4, respectively *'positive affect'* and *'negative affect'*. In order to ensure the validity of the tool, this general structure should be tested again on a new population. This would validate the new structure and confirm the composition of the 4 latent factors. Another, more radical solution would be to revise the previous step, i.e., to rework the items and possibly propose new ones in order to test via an EFA, a new and improved scale of this first version.

The creation and testing of measurement scales is a complex process that requires several steps. The two tools presented here are acceptable in their final form, although not optimal. The difficulty in obtaining a scale with a well-defined structure could be based on several elements.

Firstly, the construction of the items was carried out taking into account the literature on the one hand, and more methodological considerations on the other. Indeed, it was necessary to develop measurement tools that could be easily used in experiments containing other tasks and/or scales. It was therefore not possible to construct scales with too many items each. In doing so, I may have imposed a methodological limitation on myself from the outset that did not allow for a sufficiently complete scale. Secondly, the measurement of negative attitudes towards people of North-African origin was difficult. Particularly in its construction, where the choice of items revolved around two attitudes' supposed basis. Attitudes can be seen as tripartite: based on affect, behaviour and cognition. However, it is possible to focus on those that are considered most important and powerful in predicting behaviour (Millar & Tesser, 1992). With this in mind, and given the choices made in the literature, I have chosen to focus on cognitive and affective attitudes. In order to limit the social desirability effect as much as possible, the majority of items dealing with cognitive attitudes were indirect. This choice, according to Axt (2017), would not necessarily be the most suitable to best measure explicit attitudes. Thus, it might have been beneficial to include more direct items in this scale. Besides, although an effort was made to propose items of different valence (negative vs. positive), all items on adherence to North-African culture were positively oriented. It would have been preferable for this theme to have an equivalent distribution between positive and negative valence items, in particular to avoid a latent factor structure such as that obtained with the CFA, where a large majority of the positive valence items concern the North-African culture and where, conversely, none of the negative valence items do.

Another element concerns the conditions under which the experiment was conducted, particularly for the confirmatory analysis. Indeed, the CFA was carried out on the basis of the answers to the contact and prejudice questionnaires during two different data collections. One took place face-to-face and in the presence of an experimenter (see Chapter 2), while the second took place online and was completely anonymous (see Chapter 4). It is possible that these two settings did not favour the same conditions for filling in the questionnaire and that the way in which the participants responded was different. As a result, the general structure identified in

the CFA may have been affected. On the one hand, the multiplicity of conditions for filling in the questionnaires may have been beneficial, as it enabled the validation of a tool that could be adapted to different modes of administration. On the other hand, the face-to-face sessions in particular may have accentuated responses influenced by social desirability, creating a discrepancy with the responses given anonymously online. This may have made it more difficult to establish a clear structure during the CFA.

Similarly, the data used for the CFA were collected after a recognition task in both periods of data collection. Ideally, it would have been preferable to conduct data collection where only the questionnaire was completed so as not to influence the responses to the questions in any way depending on the task. Besides, completing the contact and prejudice questionnaires simultaneously may have also affected both types of analysis. The aim was to validate two separate scales, which in this thesis are always used concomitantly, but are not necessarily intended to be used in this way in future research. However, it is possible that completing one of the questionnaires had an impact on the responses to the other.

Finally, the question of the number of participants remains important. As summarised in the work of Taherdoost et al. (2014), very different recommendations can be found in the literature regarding the ideal number of participants for factor analyses. One of them, which is particularly popular, is to propose a minimum of 10 participants per item for a single construct. In the case of the EFA, the largest scale (the prejudice scale) had 28 items, so a minimum of 280 participants would have been necessary.

Appendix C

Table C.1

Items origin for the social contact habits with North African individuals.

	Items (in French)	Items (in English)[20]	Source
Avoidance			
Q3-1	Quand je suis en voiture en ville, je préfère éviter les quartiers avec une forte présence de personnes d'origine maghrébine.	When I drive in the city, I prefer to avoid neighbourhoods where there is a strong presence of people of North African origin.	Inspired by Durrheim and colleagus (not published)
Q3-2	Il m'arrive de faire un détour pour éviter le contact avec des personnes d'origine maghrébine.	Sometimes I make a diversion to avoid contact with people of North African origin.	Inspired by Durrheim and colleagus (not published)
Q3-3	En général, j'essaie d'éviter les quartiers avec une forte présence de personnes d'origine maghrébine.	In general, I try to avoid neighbourhoods where there is a strong presence of people of North African origin.	Original
Q3-4	Lorsque j'ai choisi mon logement (appartement, chambre, maison, etc..), j'ai évité les quartiers avec une forte présence d'origine maghrébine.	When I chose my accommodation (flat, room, house, etc.), I avoided areas with a strong North African presence.	Original

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[20] Please note that those translation were made for the purpose of this PhD english reader but were not tested as such and if an english-speaker researcher wish to use this scale, one should double-peer translate all items and test them out.

Q3-5	Lorsque je me déplace à pieds en ville, je favorise le passage par des quartiers avec une forte présence de personnes du même groupe ethnique que le mien.	When I walk in the city, I prefer to pass through areas where there is a strong presence of people from the same ethnic group as mine.	Inspired by Durrheim and colleagus (not published)
Q3-6	Lorsque je choisis un restaurant, un bar ou une discothèque, j'évite les endroits avec une forte présence de personnes d'origine maghrébine.	When I choose a restaurant, bar or club, I avoid places where there is a strong presence of people of North African origin.	Inspired by Durrheim and colleagus (not published)
Q3-7	De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de conflits internationaux.	In general, when I talk to a person of North African origin, I prefer to avoid talking about international conflicts.	Orginal
Q3-8	De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de terrorisme.	De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de terrorisme.	Original
Q3-9	De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter certain sujets tels que la laïcité ou la religion.	Generally speaking, when I discuss with a person of North African origin, I prefer to avoid certain subjects such as secularism or religion.	Original
Q3-10	Les personnes d'origine européenne et les personnes d'origine maghrébine ne pourront jamais être totalement à l'aise les unes avec les autres, même si elles se considèrent comme amies.	People of European origin and people of North African origin can never be completely at ease with each other, even if they consider themselves friends.	Original

Quantity

Q4-1	Parmi vos amis, combien sont d'origine maghrébine ?	How many of your friends are of North African origin?	Inspired by Pettigrew (1997) and Islam & Hewstone (1993)
Q4-12	Je connais beaucoup de personnes d'origine maghrébine.	I know many people of North African origin.	Hancock & Rhodes (2008)
Q4-13	J'interragis fréquemment avec des personnes d'origine maghrébine.	I frequently interact with people of North African origin.	Inspired by Hancock & Rhodes (2008)
Q4-14	Je vis ou ai vécu dans une région où j'interagis/j'interagissais avec beaucoup de personnes d'origine maghrébine.	I live or have lived in an area where I interact/interacted with many people of North African origin.	Hancock & Rhodes (2008)
Q4-15	J'interagis quotidiennement avec des personnes d'origine maghrébine.	I interact daily with people of North African origin.	Hancock & Rhodes (2008)
Q4-16	En général, je n'interagis qu'avec des personnes d'origine maghrébine.	In general, I only interact with people of North African origin.	Hancock & Rhodes (2008)

Quality

Q4-4	Dans quelle proportion vous sentez-vous dévalorisé.e par des personnes d'origine maghrébine ?	To what extent do you feel devalued by people of North African origin?	Inspired by the Belfast Mobility project questionnaire
Q4-5	Dans quelle proporition vivez-vous des expériences désagréables avec des personnes d'origine maghrébine ?	How often do you have unpleasant experiences with people of North African origin?	Inspired by the Belfast Mobility project questionnaire

			And Dhont & Van Hiel (2009)
Q4-6	Dans quelle proportion avez-vous des expériences amicales avec des personnes d'origine maghrébine ?	In what proportion do you have friendly experiences with people of North African origin?	Inspired by the Belfast Mobility project questionnaire And Arnadottir et al. (2018) And Dhont & Van Hiel (2009)
Q4-7	Dans quelle proportion avez-vous des interactions sociales négatives avec des personnes d'origine maghrébine ?	In what proportion do you have negative social interactions with people of North African origin?	Inspired by the Belfast Mobility project questionnaire And Arnadottir et al. (2018)
Q4-8	Dans quelle proportion vivez-vous des expériences enrichissantes avec des personnes d'origine maghrébine ?	In what proportion do you have enriching experiences with people of North African origin?	Inspired by the Belfast Mobility project questionnaire
Q4-9	Dans quelle proportion avez-vous des interactions sociales positives avec des personnes d'origine maghrébine ?	In what proportion do you have positive social interactions with people of North African origin?	Inspired by the Belfast Mobility project questionnaire And Islam & Hewstone (1993)

| Q4-10 | Dans quelle proportion vous sentez-vous insulté.e par des personnes d'origine maghrébine ? | In what proportion do you feel insulted by people of North African origin? | Inspired by the Belfast Mobility project questionnaire |
| Q4-11 | Dans quelle proportion vous sentez-vous accueilli.e par des personnes d'origine maghrébine ? | In what proportion do you feel welcomed by people of North African origin? | Inspired by the Belfast Mobility project questionnaire |

Appendix D

Table D.2

Items origin from the Prejudice scale towards North African individuals before validation

	Items (in French)	Items (in English)[21]	Source
Adhesion to discriminatory behaviour			
Q1-1	Je pense qu'il peut exister des éléments objectifs expliquant les réticences d'employeurs pour le recrutement de personnes d'origine maghrébine.	I think there may be objective reasons for the reluctance of employers to recruit people of North African origin.	Original
Q1-2	Je pense qu'il n'existe pas d'éléments objectifs expliquant les réticences d'employeurs pour le recrutement de personnes d'origine maghrébine.	I think there is no objective evidence to explain the reluctance of employers to recruit people of North African origin.	Original
Q1-3	Je pense qu'il existe une importante discrimination à l'emploi à l'égard des personnes d'origine maghrébine.	I believe that there is significant discrimination in employment against people of North African origin.	Inspired by Katz & Hass (1988)

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[21] Please note that those translation were made for the purpose of this PhD english reader but were not tested as such and if an english-speaker researcher wish to use this scale, one should double-peer translate all items and test them out.

Q1-4	Je pense qu'on surestime la discrimination à l'emploi à l'égard des personnes d'origine maghrébine.	I think that employment discrimination against people of North African origin is overestimated.	Inspired by Katz & Hass (1988)
Q1-5	Je pense que les personnes d'origine maghrébine rencontrent d'importantes difficultés pour louer un logement en raison de leur origine ethnique.	I think that people of North African origin face great difficulties in renting housing because of their ethnic origin.	Original
Q1-6	Je pense que les lois en France sont globalement suffisantes pour empêcher toute discrimination lorsqu'une personne d'origine maghrébine veut louer un appartement.	I think that the laws in France are generally sufficient to prevent discrimination when a person of North African origin wants to rent a flat.	Original
Q1-7	Je pense qu'il peut exister des éléments objectifs expliquant les réticences d'un propriétaire à louer son appartement à des personnes d'origine maghrébine.	I believe that there may be objective reasons for a landlord's reluctance to rent his flat to people of North African origin.	Original
Q1-8	Je pense qu'il est anormal que des personnes d'origine maghrébine se voient refuser l'entrée	I think it is abnormal that people of North African origin are refused entry to nightclubs because of their ethnic origin.	Original

	en boîte de nuit en raison de leur origine ethnique.		
Q1-9	Je pense qu'il peut exister des éléments objectifs expliquant les réticences du personnel de sécurité à accepter l'entrée en boîte de nuit de personnes d'origine maghrébine.	I think there may be objective reasons for the reluctance of security staff to allow people of North African origin into nightclubs.	Original
Q1-10	Je considère que la société française est injuste envers les personnes d'origine maghrébine.	I consider that French society is unfair to people of North African origin.	Dambrund & Guimond (2001)
Q1-11	Je considère que la société française fait beaucoup d'efforts envers les personnes d'origine maghrébine.	I consider that French society makes a lot of efforts towards people of North African origin.	Dambrung & Guimond (2001)
Appreciation of the North-African culture			
Q1-12	La religion musulmane m'intéresse.	I am interested in the Muslim religion.	Inspired by Meertens & Pettigrew (1997)
Q1-13	J'aime écouter de la musique maghrébine.	I like to listen to North African music.	Original

Q1-14	Mes valeurs sont proches des valeurs des personnes d'origine maghrébine.	My values are close to the values of people of North African origin.	Inspired by Meertens & Pettigrew (1997)
Q1-15	Je pense qu'il a été/est/serait très enrichissant pour moi d'apprendre l'arabe.	I think it has been/is/will be very rewarding for me to learn Arabic.	Inspired by Meertens & Pettigrew (1997)
Q1-16	J'aime réaliser des recettes de cuisine maghrébine.	I like to make Maghrebi recipes.	Original
Q1-17	Je pense que, pour un employeur, les compétences d'un candidat devrait plus compter que son origine ethnique.	I think that, for an employer, a candidate's skills should count more than his or her ethnic origin.	Original
Q1-18	Je peux comprendre qu'un employeur, lors d'un recrutement, tienne compte de l'origine ethnique maghrébine d'un candidat parmi d'autres critères.	I can understand that an employer, when recruiting, takes into account the North African ethnic origin of a candidate among other criteria.	Inspired by Katz & Hass (1988)
Q1-19	Je pense que ce qui devrait compter pour le propriétaire d'un appartement cherchant des locataires, ce sont les garanties financières du candidat et non son origine ethnique.	I think that what should count for the owner of a flat looking for tenants is the financial guarantees of the applicant and not his or her ethnic origin.	Original

Q1-20	Je pense que les médias traitent trop de la situation des personnes d'origine maghrébine.	I think that the media deals too much with the situation of people of North African origin.	Original
Q1-21	Je trouve que la situation des personnes d'origine maghrébine est peu traitée dans les médias.	I find that the situation of people of North African origin is little covered in the media.	Original
Q1-22	J'apprécie la culture du Maghreb (la langue arabe, la gastronomie, la littérature, l'art visuel, la musique, la danse, le patrimoine, la peinture, etc.).	I appreciate the culture of the Maghreb (the Arabic language, gastronomy, literature, visual art, music, dance, heritage, painting, etc.).	Inspired by Meertens & Pettigrew (1997)

Affective attitudes

Q5-1	Je me sens en confiance avec les personnes d'origine maghrébine.	I feel confident around people of North African origin.	Inspired by Meertens & Pettigrew (1997)
Q5-2	J'apprécie interagir avec une personne d'origine maghrébine.	I enjoy interacting with a person of North African origin.	Inspired by Meertens & Pettigrew (1997)
Q5-3	Interagir avec une personne d'origine maghrébine est enrichissant.	Interacting with a person of North African origin is enriching.	Inspired by Meertens & Pettigrew (1997)

Q5-4	Je ne me sens pas à l'aise avec des personnes d'origine maghrébine.	I don't feel comfortable with people of North African origin.	Inspired by Meertens & Pettigrew (1997)
Q5-5	Je n'aime pas rencontrer de nouvelles personnes d'origine maghrébine.	I don't like meeting new people of North African origin.	Inspired by Meertens & Pettigrew (1997)
Q5-6	Je me sens menacé par les personnes d'origine maghrébine.	I feel threatened by people of North African origin.	Inspired by Meertens & Pettigrew (1997)

Appendix E

Box E.1
Prejudice scale with the structure given by CFA

Factor 1 : Indirect expression of prejudice

Q1-1 : Je pense qu'il peut exister des éléments objectifs expliquant les réticences d'employeurs pour le recrutement de personnes d'origine maghrébine
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think there may be objective reasons for the reluctance of employers to recruit people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-2 : Je pense qu'il n'existe pas d'éléments objectifs expliquant les réticences d'employeurs pour le recrutement de personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think there is no objective evidence to explain the reluctance of employers to recruit people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-7 : Je pense qu'il peut exister des éléments objectifs expliquant les réticences d'un propriétaire à louer son appartement à des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I believe that there may be objective reasons for a landlord's reluctance to rent his flat to people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-19 : Je pense que ce qui devrait compter pour le propriétaire d'un appartement cherchant des locataires, ce sont les garanties financières du candidat et non son origine ethnique.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think that what should count for the owner of a flat looking for tenants is the financial guarantees of the applicant and not his or her ethnic origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Factor 2 : Direct expression of prejudice

Q1-3 : Je pense qu'il existe une importante discrimination à l'emploi à l'égard des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I believe that there is significant discrimination in employment against people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-4 : Je pense qu'on surestime la discrimination à l'emploi à l'égard des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think that employment discrimination against people of North African origin is overestimated.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-5 : Je pense que les personnes d'origine maghrébine rencontrent d'importantes difficultés pour louer un logement en raison de leur origine ethnique.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think that people of North African origin face great difficulties in renting housing because of their ethnic origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-6 : Je pense que les lois en France sont globalement suffisantes pour empêcher toute discrimination lorsqu'une personne d'origine maghrébine veut louer un appartement.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I think that the laws in France are generally sufficient to prevent discrimination when a person of North African origin wants to rent a flat.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-10 : Je considère que la société française est injuste envers les personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I consider that French society is unfair to people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-11 : Je considère que la société française fait beaucoup d'efforts envers les personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I consider that French society makes a lot of efforts towards people of North African origin.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

Factor 3 : affect towards North African culture (or Positive affect)

        Q1-12 : La religion musulmane m'intéresse.
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'I am interested in the Muslim religion.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

        Q1-13 : J'aime écouter de la musique maghrébine.
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'I like to listen to North African music.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

        Q1-14 : Mes valeurs sont proches des valeurs des personnes d'origine maghrébine.
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'My values are close to the values of people of North African origin.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

        Q1-15 : Je pense qu'il a été/est/serait très enrichissant pour moi d'apprendre l'arabe.
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'I think it has been/is/will be very rewarding for me to learn Arabic.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

        Q1-16 : J'aime réaliser des recettes de cuisine maghrébine.
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'I like to make Maghrebi recipes.'
        Strongly disagree   -   Rather disagree   -   Neither agree nor disagree   -   Rather agree   -   Totally agree

        Q1-22 : J'apprécie la culture du Maghreb (la langue arabe, la gastronomie, la littérature, l'art visuel, la musique, la danse, le patrimoine, la peinture, etc.).
        Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

        'I appreciate the culture of the Maghreb (the Arabic language, gastronomy, literature, visual art, music, dance, heritage, painting, etc.).'

Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-1 : Je me sens en confiance avec les personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I feel confident around people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-2 : J'apprécie interagir avec une personne d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I enjoy interacting with a person of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-3 : Interagir avec une personne d'origine maghrébine est enrichissant.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'Interacting with a person of North African origin is enriching.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Factor 4 : General affect towards North-African (or Negative affect)

Q5-4 : Je ne me sens pas à l'aise avec des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I don't feel comfortable with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-5 : Je n'aime pas rencontrer de nouvelles personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I don't like meeting new people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-6 : Je me sens menacé par les personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I feel threatened by people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Box E.2

Contact scale with the structure given by CFA

Factor 1: Positive contact

Q4-1 : Parmi vos amis, combien sont d'origine maghrébine ?
Aucun – Quelques uns – La moitié d'entre eux – La plupart d'entre eux - Tous

'How many of your friends are of North African origin?'
None - Some of them - Half of them - Most of them - All

Q4-6 : Dans quelle proportion avez-vous des expériences amicales avec des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you have friendly experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-8 : Dans quelle proportion vivez-vous des expériences enrichissantes avec des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you have enriching experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-9 : Dans quelle proportion avez-vous des interactions sociales positives avec des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you have positive social interactions with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-11 : Dans quelle proportion vous sentez-vous accueilli.e par des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you feel welcomed by people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-12 : Je connais beaucoup de personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I know many people of North African origin'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q4-13 : J'interragis fréquemment avec des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I frequently interact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q4-14 : Je vis ou ai vécu dans une région où j'interagis/j'interagissais avec beaucoup de personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I live or have lived in an area where I interact/interacted with many people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q4-15 : J'interagis quotidiennement avec des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'I interact daily with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q4-16 : En général, je n'interagis qu'avec des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'In general, I only interact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Factor 2 : Physical avoidance

Q3-1 : Quand je suis en voiture en ville, je préfère éviter les quartiers avec une forte présence de personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'When I drive in the city, I prefer to avoid neighbourhoods where there is a strong presence of people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-2 : Il m'arrive de faire un détour pour éviter le contact avec des personnes d'origine maghrébine.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'Sometimes I make a diversion to avoid contact with people of North African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-3 : En général, j'essaie d'éviter les quartiers avec une forte présence de personnes d'origine maghrébine.

Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'In general, I try to avoid neighbourhoods where there is a strong presence of people of North African origin.'

Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-4 : Lorsque j'ai choisi mon logement (appartement, chambre, maison, etc..), j'ai évité les quartiers avec une forte présence d'origine maghrébine.

Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'When I chose my accommodation (flat, room, house, etc.), I avoided areas with a strong North African presence.'

Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-5 : Lorsque je me déplace à pieds en ville, je favorise le passage par des quartiers avec une forte présence de personnes du même groupe ethnique que le mien.

Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'When I walk in the city, I prefer to pass through areas where there is a strong presence of people from the same ethnic group as mine.'

Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-6 : Lorsque je choisis un restaurant, un bar ou une discothèque, j'évite les endroits avec une forte présence de personnes d'origine maghrébine.

Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'When I choose a restaurant, bar or club, I avoid places where there is a strong presence of people of North African origin.'

Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Factor 3 : Negative contact

Q4-4 : Dans quelle proportion vous sentez-vous dévalorisé.e par des personnes d'origine maghrébine ?

Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'To what extent do you feel devalued by people of North African origin?'

Never - Sometimes - Hald of the time - Often - Everytime

Q4-5 : Dans quelle proportion vivez-vous des expériences désagréables avec des personnes d'origine maghrébine ?

Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'How often do you have unpleasant experiences with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-7 : Dans quelle proportion avez-vous des interactions sociales négatives avec des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you have negative social interactions with people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Q4-10 : Dans quelle proportion vous sentez-vous insulté.e par des personnes d'origine maghrébine ?
Jamais - Quelques fois - La moitié du temps - Souvent - Tout le temps

'In what proportion do you feel insulted by people of North African origin?'
Never - Sometimes - Hald of the time - Often - Everytime

Factor 4: Conversation subject avoidance

Q3-7 : De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de conflits internationaux.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'In general, when I talk to a person of North African origin, I prefer to avoid talking about international conflicts.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-8 : De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de terrorisme.
Pas du tout d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter de parler de terrorisme.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q3-9 : De manière générale, lorsque je discute avec une personne d'origine maghrébine, je préfère éviter certain sujets tels que la laïcité ou la religion.
Pas du toutt d'accord - Plutôt en désaccord - Ni d'accord, ni en désaccord - Plutôt d'accord - Tout à fait d'accord

'Generally speaking, when I discuss with a person of North African origin, I prefer to avoid certain subjects such as secularism or religion.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Appendix F

Figure F.1

*Plotting ot interaction effect between self reported contact and the group on d'*
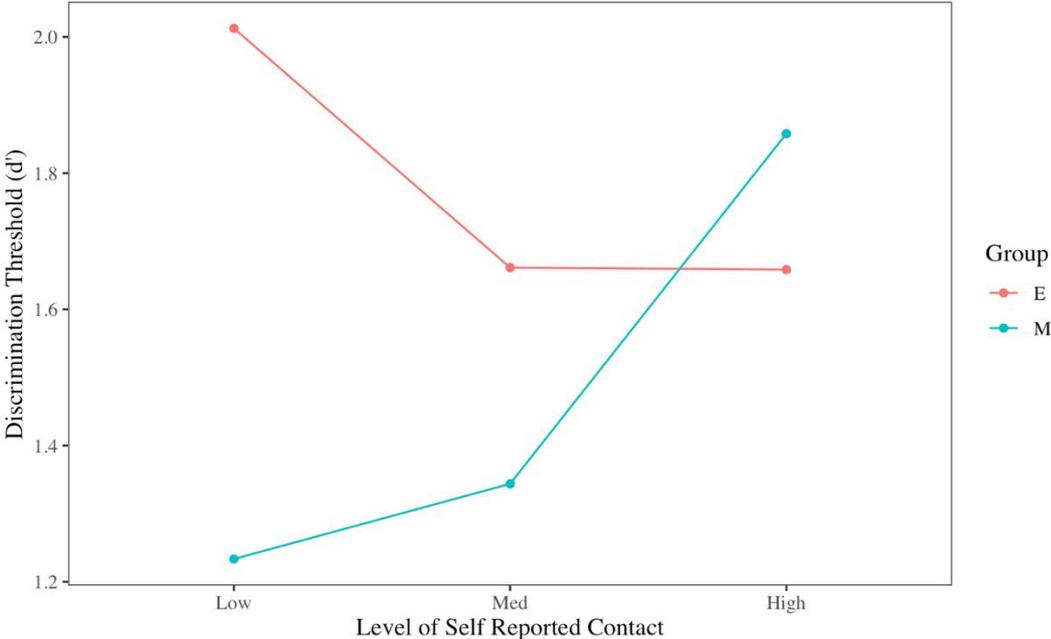
Note. The interaction illustrated in this Figure did not reach significance in the model

Appendix G

Figure G.1

Plotting of interaction between the AOI and the self reported social contact on the number of fixation
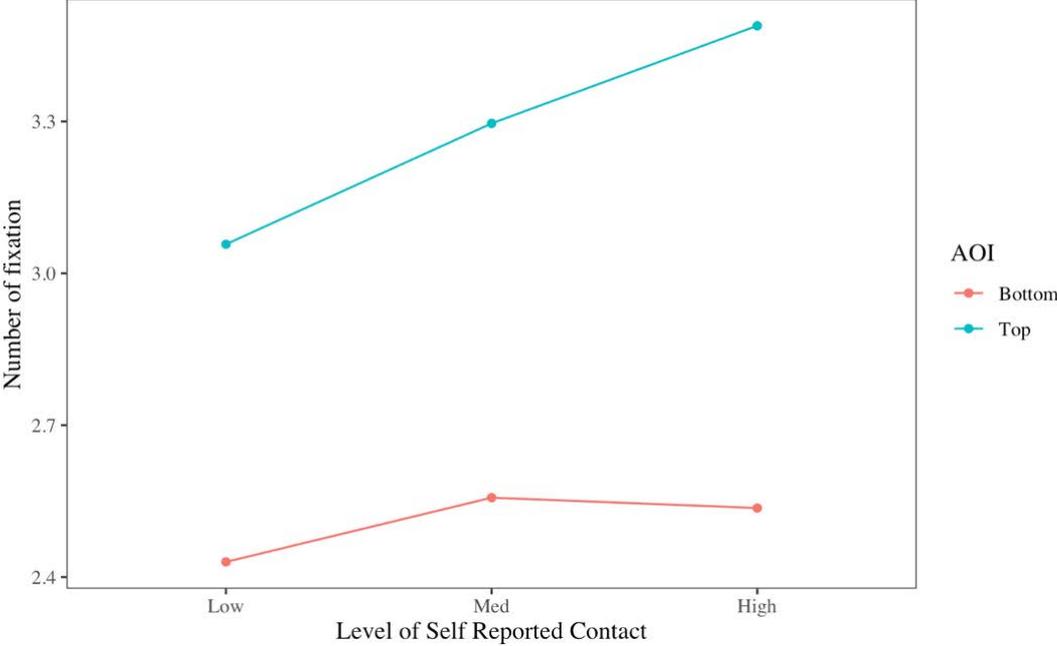

Note. The high level of self reported contact are associated with an increasing number of fixation on the top area of the face.

Appendix H

Figure H.1

Plotting of interaction between the group and the self reported social contact on the number of fixation
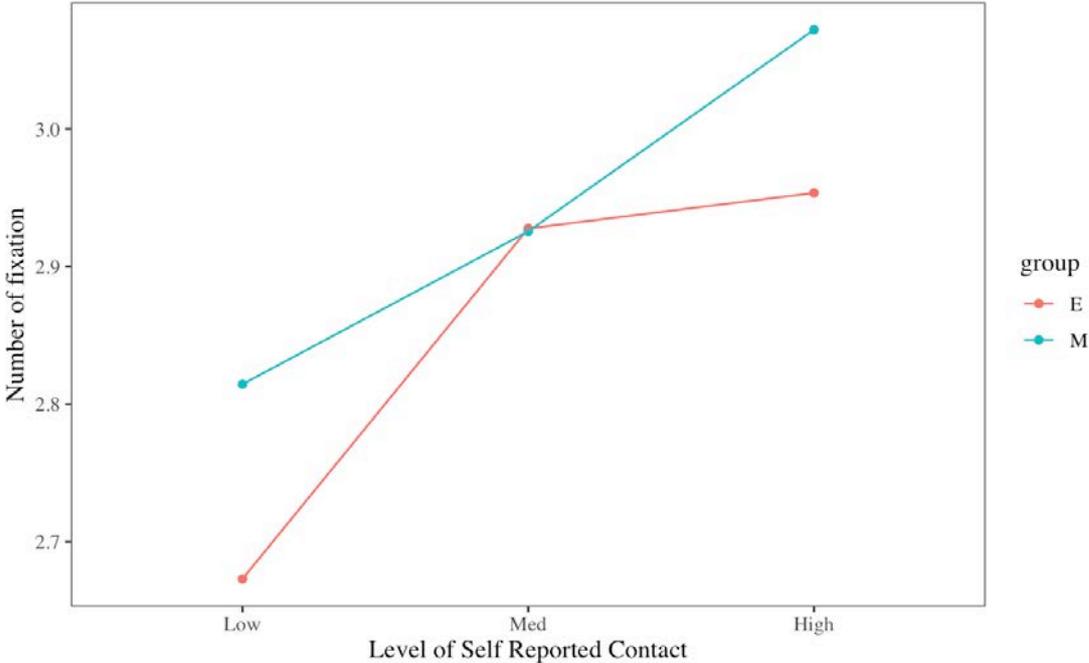

Note. Group legend : E = European; M = North-African (Maghrebian)

The self reported contact seems to be associated for higher number of fixation on low and high condition for the North-African faces compared to European faces. However, no difference are visible for the medium condition.

Appendix I

Figure I.1

Plotting of interaction between the AOI and the avoidance of contact on the number of fixation
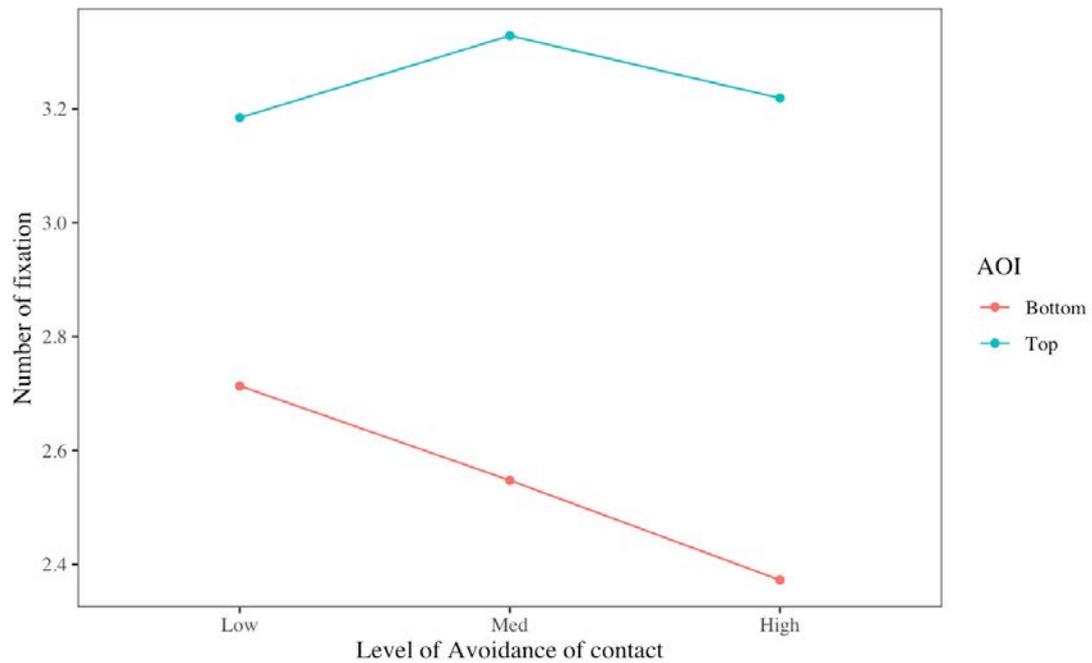
Note. The level of avoidanc e of contact seems to decrease the number of fixation on the bottom area of the face.

Appendix J

Table J.1

Description of studies included and excluded after the first screening

Date	Authors	Title	Inclusion/Exclusion
1996	Atkinson et al.	African American client skin tone and clinical judgement of African American and European Psychologists	Excluded No measure of attitudes
2002	Blair et al.	The role of afrocentric features in person perception : judging by features and categories	Included
2004	Blair et al.	The automaticity of race and afrocentric facial features in social judgment	Included
2018	Cowart & Lehnert	Empirical evidence of the effect of colorism on customer evaluations	Included
2020	Deska et al.	Black racial phenotypicality shapes social pain and support judgements	Included
2020	Horward & Borgella	Are Adewale and Ngochi more employable than Jamal and Lakeisha ? The influence of nationality and ethnicity cues on employment-related evaluations of Blacks in the United States.	Excluded No manipulation of perceived ethnic typicality
2009	Kaiser & Pratt-Hyatt	Distributing prejudice unequally : do whites direct their prejudice toward strongly identified minorities ?	Excluded No manipulation of perceived ethnic typicality
2019	Kleider-Offutt	Afraid of one afraid of all : when threat associations spread across face-types	Excluded No data on direct effect of perceived ethnic typicality on attitudes

2021	Kurdi et al.	Specificity and incremental predictive validity of implicit attitudes : studies of a race-based phenotype	Included
2001	Livingston	What you see is what you get : systematic variability in perceptual-based social judgment	Excluded No data on direct effect of perceived ethnic typicality on attitudes
2018	Ma et al.	The effecys of category and physical features on sterotyping and evaluation	Included
2016	Meeus et al.	Racial phenotypicality bias in educational expectations for both male and female teenagers from different socioeconomic backgrounds	Excluded No White participant
2016	Painter II et al.	Skin tone, race/ethnicity, and wealth inequality among new immigrants	Excluded No measure of attitudes
2012,b	Stepanova & Strube	What's in a face? The role of skin tone, facial physiognomy, and color presentation mode of facial primes in affective priming effect	Included
2013	Stepanova et al.	Now one is Russian, now one is not : ethnic attitudes and categorization effects in the Russian Federation	Excluded No data on direct effect of perceived ethnic typicality on attitudes
2019	Williams et al.	The face of STEM: racial phenotypic stereotypicality predicts STEM persistence by- and ability attributions about- students of color	Included

Appendix K

Table K.1

Description of studies included and excluded after thecitation searching (2nd method)

Date	Authors	Title	Inclusion/Exclusion
2006	Blair	The efficient use of race and afrocentric features in inverted faces	Included
2005	Dixon & Maddox	Skin tone, crime news, and social reality judgments : priming the stereotype of the dark and dangerous black criminal	Excluded No measure of attitudes
2012	Hagiwara et al.	The independent effects of skin tone and facial features on Whites' affective reactions to black	Included
2014	Hannon	Hispanic respondent intelligence level and skin tone : interviewer perceptions from the american national election study	Included
2020	Koval & Rosette	The natural hair bias in job recruitment	Excluded No manipulation of perceived ethnic typicality
2010	Levinson & Young	Different shades of bias : skin tone, implicit racial bias, and judgments of ambiguous evidence	Excluded No measure of attitudes
2002	Livingston & Brewer	What are we really priming ? Cue-based versus category-based processing of facial stimuli	Included
2002	Maddox & Gray	Cognitive representations of black Americans : reexploring the role of skin tone	Included
2015	Oppie & Phillips	Hair penalties : the negative influence of afrocenric hair on ratings of black women's dominance and professionalism	Included

Appendix L

Box L.1. **Prejudice Scales adapted toward African individuals**
Q1-1: 'I think there may be objective reasons for the reluctance of employers to recruit people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-2: 'I think there is no objective evidence to explain the reluctance of employers to recruit people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-7: 'I believe that there may be objective reasons for a landlord's reluctance to rent his flat to people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-19: 'I think that what should count for the owner of a flat looking for tenants is the financial guarantees of the applicant and not his or her ethnic origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-3: 'I believe that there is significant discrimination in employment against people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-4: 'I think that employment discrimination against people of African origin is overestimated.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-5: 'I think that people of African origin face great difficulties in renting housing because of their ethnic origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-6: 'I think that the laws in France are generally sufficient to prevent discrimination when a person of African origin wants to rent a flat.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-10:'I consider that French society is unfair to people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-11: 'I consider that French society makes a lot of efforts towards people of African origin.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-12:'I am interested in the African religion.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree Q1-13: 'I like to listen to African music.' Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-14: 'My values are close to the values of people of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-15: 'I think it has been/is/will be very rewarding for me to learn an African language.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-16: 'I like to make African recipes.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q1-22: 'I appreciate the African culture (the African language, gastronomy, literature, visual art, music, dance, heritage, painting, etc.).'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-1: 'I feel confident around people of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-2: 'I enjoy interacting with a person of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-3: 'Interacting with a person of African origin is enriching.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-4: 'I don't feel comfortable with people of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-5: 'I don't like meeting new people of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree

Q5-6: 'I feel threatened by people of African origin.'
Strongly disagree - Rather disagree - Neither agree nor disagree - Rather agree - Totally agree