THE INFLUENCE OF BABY SCHEMA EFFECT AND MERE EXPOSURE EFFECT ON IMPLICIT AND EXPLICIT FACE PROCESSING: A FOLLOW-UP STUDY

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Faces are pivotal social stimuli that convey a tremendous amount of information and trigger numerous cognitive processes and consequent behaviors. Among the numerous factors that mediate face perception, we focused our attention on two particular phenomena and their interaction: the Baby Schema effect (BSE) and the Mere Exposure effect (MEE). Accordingly to the BSE, babies' features are considered "cuter" than adults' features and motivate people towards protection and caregiving, while the MEE states that familiarity can increase the likeability of various stimuli, including faces. To investigate how those two factors interact, we carried out a follow-up study of the work of Venturoso et al. (2019) on a Singaporean sample. Singapore is a multicultural city-state where different ethnicities live alongside each other. Participants (ethnic Chinese and Indian) were shown faces of female adults and babies of different ethnic groups (Caucasian, Indian, Chinese and Arabic). Implicit responses were recorded using pupillometry measures, while explicit attitudes were assessed using a questionnaire. Our results confirm the presence of the BSE in both the explicit and implicit measures; specifically, baby faces elicited greater pupillary variations and were rated as more attractive than adult faces. An interaction effect between age and ethnicity was also observed. On the other hand, differences in pupil diameters and pleasantness scores were found between the ethnic groups on adult faces. The above-mentioned differences did not depend on whether stimuli belonged to the ethnic in-group or out-group of the participants, suggesting that exposure to individuals of different ethnicities reduces in-group favoritism. Further investigation is needed to better understand the complex interaction between BSE and MEE in our increasingly multifaceted reality.

ВЛИЯНИЕ ЭФФЕКТА ДЕТСКОГО ЛИЦА И ЭФФЕКТА ЗНАКОМСТВА С ОБЪЕКТОМ НА ИМПЛИЦИТНЫЙ И ЭКСПЛИЦИТНЫЙ АСПЕКТЫ ПЕРЕРАБОТКИ ИНФОРМАЦИИ О ВОСПРИНИМАЕМЫХ ЛИЦАХ: ДОПОЛНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ

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Лица — это основные социальные стимулы, которые передают огромное количество информации и запускают многочисленные когнитивные процессы и последующее поведение. Среди множества факторов, которые опосредуют восприятие лица, мы сосредоточили наше внимание на двух конкретных явлениях и их взаимодействии: эффект детского лица (BSE) и эффект знакомства с объектом (MEE). Согласно BSE, черты лица младенцев считаются «более симпатичными», чем черты взрослых, и мотивируют людей к защите и уходу, в то время как MEE утверждает, что знакомство может повысить привлекательность различных стимулов, включая лица. Чтобы изучить, как эти два фактора взаимодействуют, мы провели дополнительное исследование работы Venturoso et al. (2019) на сингапурской выборке. Сингапур — многокультурный город-государство, в котором совместно проживают разные этнические группы. Участникам (этническим китайцам и индийцам) были показаны лица взрослых женщин и младенцев из разных этнических групп (европейцы, индийцы, китайцы и арабы). Неявные ответы регистрировались с использованием пупиллометрии, а явные отношения оценивались с помощью анкеты. Наши результаты подтверждают присутствие BSE в измерениях обоих типов: в частности, детские лица вызывали большие вариации в изменении диаметра зрачка и оценивались как более привлекательные, чем лица взрослых. Также наблюдался эффект взаимодействия между возрастом и этнической принадлежностью. С другой стороны, между этническими группами были обнаружены различия в показателях диаметра зрачка и приятности при демонстрации лиц взрослых. Вышеупомянутые различия не зависели от того, принадлежали ли стимулы к этнической внутренней или внешней группе участников, что позволяет предположить, что предъявление лиц разных этнических групп снижает внутригрупповой фаворитизм. Необходимы дальнейшие исследования, чтобы лучше понять сложное взаимодействие между BSE и MEE в нашей все более многогранной реальности.

Ключевые слова: эффект детского лица, эффект знакомства с объектом, пупиллометрия, лица, привлекательность, этнические лица.

Introduction

Society is changing deeply, becoming much more multicultural and diverse by the day. Therefore, studying how people perceive one another becomes pivotal for a better understanding of our reality. It is well-known that faces play a key role in social cognition, allowing for the immediate exchange of complex information (e.g., sex, age, ethnicity, emotions) that can influence people's behaviors and attitudes [49].

One of the most studied phenomena related to face perception is the Baby Schema Effect (BSE). The BSE was first described by K. Lorenz and can be referred to as the set of morphological and behavioral features (such as big head, large eyes, prominent cheeks) typical in human and animal babies that activate specific neural systems in adults, resulting in caregiving or protective behaviors and affective responses [8, 12, 14, 29, 33]. From an evolutionary point of view, BSE is pivotal for child survival and well-being; it captures adults' attention [7] and increases the perception of cuteness and motivation for caretaking and protection [2, 15, 34]. BSE is so strong that infantile facial features affect 'cuteness' perception and gaze allocation towards non-human stimuli such as dogs and cats [4] and influences affective responses even towards non-biological stimuli such as car bumpers [36]. Nonetheless, BSE is modulated by variables such as gender. Specifically, it seems that women show greater and more stable attention towards babies compared to men, and generally, BSE is positively associated with the female gender [17, 31]. Other authors suggest that even though infant features have similar motivational salience for both genders, females tend to have higher neurophysiological responses toward baby faces as compared to men [40].

Another important cognitive phenomenon is the Mere Exposure Effect (MEE), which is the tendency of individuals to prefer familiar things, objects, or people compared with unfamiliar ones [53]. Familiarity with an object can increase its likeability even through subconscious exposure [5] and extends to a large variety of stimuli, including people and faces [37]. MEE can affect the way people judge strangers; for instance, it is found that people tend to show in-group favoritism while evaluating stranger's faces belonging to in-group versus out-group ethnicities, probably because own-race strangers look more familiar [55]. In fact, it has been found that the subliminal exposure to other-race faces can increase the perceived pleasantness of other faces of that ethnicity [54].

Both BSE and MEE influence stimuli to, for evolutionary or empirical reasons, assume an emotional valence. The physiological emotional response can be measured with numerous techniques, including pupillometry. Pupillometry is an autonomic physiological measure that consists of the study of the pupil's width changes. It has been proven that pupil diameter is not determined solely by the intensity of light but is influenced by cognitive load, visual stimulus content, and the affective valence of relevant visual stimuli [18, 24, 39]. Several studies have pointed out that pupillometry is a reliable measure of implicit face processing [10]. Pupil dilation is linked to the activation of the autonomic system; specifically, the increase in width reflects the activity of the sympathetic branch, responsible for physiological arousal [48], while the constriction is mediated by the parasympathetic system, which is involved in the calming response. Generally, it is agreed that an increase in pupil diameter reflects greater attention towards visual stimuli [1, 25]. Interestingly, Bradley and colleagues (2008) observed that pupil size is correlated with skin conductance, another indicator of physiological arousal. It has been found that the magnitude of the dilation is linearly related to the affective intensity of the visual stimulus, regardless of its valence, being it aversive or pleasant [6, 9, 23]. More recently however, findings suggest that larger pupil diameters are associated with the viewing of unfamiliar stimuli rather than familiar ones (even if the previous exposure to the familiar stimuli was subliminal), due to the greater amount of mental effort involved in the processing of unfamiliar stimuli [52]. Taken together, pupil dilation is a reliable peripheral measure for physiological arousal and attentional effort.

The interpretation of pupil constriction is trickier and there is less consensus among researchers about the factors that cause it. What is clear is that pupil constriction is not a mere reflex but is instead mediated by high-level cognitive processes [3, 35]. Initially, it was believed

that pupil constriction was related to the pleasantness of the presented stimulus, with greater contraction for distasteful images [20] but later studies suggested that other factors intervene in pupil constriction, including familiarity [30] and attractiveness [32]. Specifically, Landi and Freiwald (2017) found that known stimuli evoked larger constrictions than unfamiliar ones, while Liao and colleagues (2020) interestingly suggested that pleasant stimuli can evoke not only pupil dilations but also constrictions. Since pupillometry is a trustworthy and non-invasive measure of visual processing, it has been widely used also in the study of face processing. By doing so, many factors can be taken into consideration, including both the characteristics of participants (e.g., gender, sexual orientation, age, mental health; [18, 19, 27; 42] and of the stimuli (e.g., gender, age, familiarity, emotional valence [16, 18, 28].

As for BSE, it has been found that women show greater pupil dilation while looking at babies than adults, while in heterosexual men the greatest dilation was found in response to images of naked women [18]. Those results are consistent with the Life History Theory (i.e. for evolutionary reason males are more mating-oriented while females tend to pay more attention towards parental care) and confirm that gender plays a role in the modulation of BSE. Other authors have since focused on the role of ethnicity on BSE [11, 13]. Hu, Wang, Fu, Quinn, and Lee (2014) pointed out that both children and adults engage in different scanning strategies (amplitude of saccades, proportional fixation on the nose and mouth) while looking at in-group and out-group faces, suggesting that visual experience leads to finer-grained face processing. Moreover, differences were found between children and adults in the above-mentioned parameters and recognition accuracy towards own-race faces, confirming the role of exposure and experience in visual processing. Additionally, larger pupil dilations were found when participants view out-group versus in-group faces, probably because the cognitive effort required for the processing is higher for unfamiliar stimuli [50].

Interestingly, some studies have pointed out that differences in pupil diameter between the two eyes are a physiological condition, which probably reflects the dominance of one of the two brain hemispheres over the other and are modulated by various factors, including gender, personality, and attentional functions [43]. It is known in visual processing that the two brain hemispheres play a different role in the processing of different kinds of information and this lateralization is reflected in pupil dilation [43, 47].

It is well known that visual perception of the other greatly influences social interactions within society. Many studies have investigated the role of age (i.e., BSE) and familiarity (i.e., MEE) in face processing, but little is known so far on how these two well-known phenomena interact. To our knowledge, there are no available studies that have investigated the interaction between these two phenomena, apart from Venturoso and colleagues (2019) who addressed this issue by measuring the pupil diameter of male and female Caucasians during the passive viewing of infant and adult female faces, which could be Caucasian (in-group) or Chinese (out-group). Explicit preferences toward the stimuli were also assessed using a questionnaire. Consistent with previous literature, Venturoso and colleagues (2019) found that female participants directed more attention (i.e. greater pupil variation) toward baby faces, regardless of their ethnicity, while in males this effect was found for out-group faces only. As for explicit attitudes, both males and females rated baby faces more positively than adult faces (with no significant difference between Caucasian and Chinese), while out-group adult faces were evaluated more negatively compared to in-group adult faces.

The present study is intended to be an extension of Venturoso and colleagues' (2019) work, and it aims to investigate how the two aforementioned effects, which are known to greatly

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influence the perception of other people, interact with each other in a compositely complex society.

The authors decided to test the reproducibility of the previous results in Singapore for two main reasons: 1) while in Italy, Caucasians constitute the majority of the population, Singapore society is much more multicultural, and people from different ethnic groups (mainly Chinese, Malays and Indians) live alongside each other; 2) the sample used in Venturoso and colleagues (2019) is composed of Caucasians only. Thus, we decided to test the results with participants from other ethnic-groups (Chinese and Indians). In order to obtain a reliable comparison, the experimental set-up remained unchanged. Given previous literature and Venturoso and colleagues' (2019) results, we advanced four main hypotheses:

1) We carried out our research in Singapore, a multi-ethnic city. Since exposure to faces of other ethnicities has been proven effective in lowering out-group bias [38, 45, 56], we expect the influence of the ethnicity of the stimuli to be lower in comparison to previous studies.

2) Since females seem to express a particular interest in children, we expected to find no differences in their attitude towards babies' faces, regardless of their ethnicity. The same results might be found also in male participants, due to the expected mild influence of the MEE.

3) As for explicit attitudes, we expect to find in women a greater physiological activation towards baby faces than adult faces, with no mediation of ethnicity, supporting the hypothesis that baby features are more influential than ethnic features among females.

4) Building upon the results reported by Venturoso and colleagues (2019), we expect to find an interaction between the age and the ethnicity of the stimuli.

Materials and methods

Participants

35 Singaporean non-parents (18 males, 17 females; 15 Indian, 20 Chinese; Mean Age = 23.03, SD = 3.24) voluntarily enrolled in the study. Participants were mainly students at the Nanyang Technological University (Singapore) and were recruited through in-campus advertisements (e.g. flyers on notice boards). At the end of the experiment, participants received monetary compensation. Exclusion criteria were being part of an ethnic group other than Chinese or Indian, as well as having a history of parenthood and/or pregnancy. Before the procedure, participants were asked to read and sign the informed consent. The study was conducted in accordance with the ethical principles stated in the Helsinki declaration.

Stimuli

Participants were shown a set of sixty-four faces (64) as stimuli. The faces were equally divided into the following categories: (i) Baby Caucasian, (ii) Baby Chinese, (iii) Baby Indian, (iv) Baby Arabic, (v) Adult Caucasian, (vi) Adult Chinese, (vii) Adult Indian, (viii) Adult Arabic (Fig. 1). Chinese and Caucasian faces were selected randomly among the stimuli previously used by Venturoso and colleagues (2019). Stimuli have been obtained from a public domain database; specifically, Caucasian faces were obtained from Computer Vision Laboratory, University of Ljubljana [41, 46], Chinese faces were acquired from Yap and colleagues (2016) [51] and Indian and Arabic faces were taken from the online database "Pexels" [22]. Adult faces were all young females aged between 20 and 45; baby stimuli were all female infants younger than a year. All faces had a neutral expression and were presented in black and white. The stimuli (13x17 cm) were edited using iOS Preview's Tools to be matched for contrast and brightness; additionally, a

gray frame was applied to all faces so that possible distracting information (hair and background) was masked (circle: d = 22 cm, area = 380 cm², circumference = 69 cm).

Fig. 1. Exmples of the 8 categories of stimuli presented

Experimental Procedure

Given that we aimed to compare our results with Venturoso and colleagues (2019), the same experimental procedure was followed. Participants sat in a quiet room, with no external sources of light. The eye tracking device (Tobii T120, screen: 34x27cm, www.tobii.com) was placed in front of the participants on a desk, and the same device was also employed to present the visual stimuli to the participants while their pupillary activity was recorded. Before the procedure, the eye-tracking device was calibrated.

In this study, a within-subject design is employed. Therefore, all participants were shown all the pictures of the faces. The presentation order of stimuli was randomized across participants. Each face was presented for 4 seconds, followed by a grey screen with a central cross used as a fixation point that was presented for 3 seconds. Pupil diameter recorded during the fixation-point screen was used as baseline (Fig. 2). During the procedure, the experimenters waited outside the room to avoid unwanted influences on the participants. After the procedure, participants received an e-mail containing a questionnaire about their attitude toward each face; specifically, each stimulus was presented again separately, together with three questions: i) How positive is your attitude toward the face?; (ii) How close do you feel to this individual?; and (iii) How much do you like this individual? Participants answered the questions by placing a cursor on a 0—10 scale, where 0 represented the most negative attitude and 100 represented the most positive response.

Analysis

Preliminary Analysis

Before starting with the analysis, we examined the pupillometry data for the presence of outliers (defined as values ±2SD above/below the mean), influential cases, normality, and homogeneity of variance. Outliers were log-transformed to conform data to normality [26]. For each participant, nine different mean width values were computed: one for each of the eight face
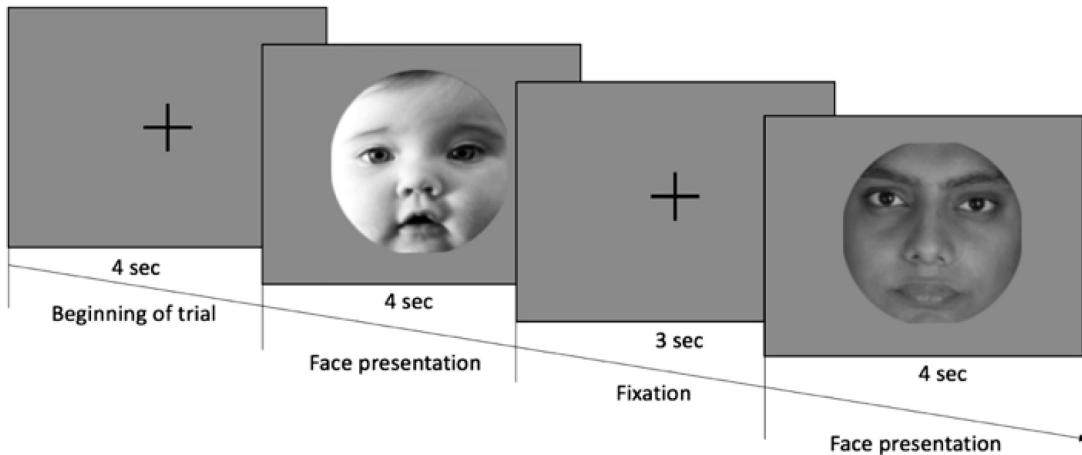
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Fig. 2. Schematic representation of the experimental procedure. Faces were presented for 4 seconds, alternated with a grey screen with a central fixation cross that was presented for 3 seconds. Fixation pupil's dilation was later used to take out baseline

categories plus one for the fixation screen, which was used as a baseline. These values were obtained by averaging pupil diameters recorded for each stimulus of the aforementioned categories. To define the variation of pupil diameter, the baseline means value was subtracted from the mean values of each stimulus category [35].

As for the explicit behavioral measures, we found a high correlation between the responses to the three questions for each face category with each other (Attitude and Closeness: Pearson's $r = 0.762$, $p < 2.2 \times 10^{-16}$; Attitude and Pleasantness: Pearson's $r = 0.848$, $p < 2.2 \times 10^{-16}$; Closeness and Pleasantness: Pearson's $r = 0.875$, $p < 2.2 \times 10^{-16}$). Consequently, we ran a linear model between pupil width and attitude scores and used the residuals of that model to measure the effect of participants' attitudes towards faces on pupil response. As with the physiological data, the behavioral responses were also examined for the presence of outliers, normality, influential cases, and homogeneity of variance. Outliers were replaced with the distribution of reference's mean.

Inferential Analysis

Two distinct three-way ANOVAs were employed, using the pupil width residuals as dependent variable (one for the left pupil, one for the right one), two within-subject factors (face age = adult/baby, face ethnic-group = Caucasian/Chinese/Indian/Arabic), and two between-subject factors (participants' sex: male/female and participants' ethnic group). Whenever significant effects were observed, post-hoc analyses were conducted by means of a Student's t-test. Bonferroni's correction was applied to take into account the increase in the risk of committing a Type I error by conducting repeated tests.

Results

Behavioral Results

The behavioral results (i.e. attitude scores) were the following: Baby Chinese (M = 58.69 ; SD = 11.53); Baby Caucasian (M = 62.93; SD = 11.83); Baby Arabic (M = 58.71 ; SD = 11.49); Baby Indian (M = 61.80 ; SD = 12.81); Adult Chinese (M = 52.04 ; SD = 8.40); Adult Caucasian (M = 41.98; SD = 12.85); Adult Arabic (M = 61.49 ; SD = 9.47); Adult Indian(M = 46.96 ; SD = 10.78).

A mixed ANOVA was performed with the attitude scores as the dependent variable, participant gender, and ethnicity as between-subject factors, and the picture characteristics (Adult/Baby, Ethnic Group) as within-subject factors.

Surprisingly, we found no significant difference in the evaluation given by females and males; for this reason, data for both participant sexes were combined for subsequent analysis. We found a significant main effect of age of face ($F(1,55) = 81.75$, $p = 1.812 \times 10^{-12}$), meaning that baby faces were preferred to adult faces regardless of their ethnicity and the viewer's gender ($t(56) = 9.11$, $p = 1.18 \times 10^{-12}$) (Fig. 3 A). Moreover, an interaction effect between age and ethnicity of face was observed ($F(3,165) = 63.02$, $p = <2 \times 10^{-16}$). More specifically, we found a significant preference towards baby faces in every ethnic group, except for Arabic faces, where babies and adults received equally positive scorings (Baby/Adult Caucasian: $t(56)= 5.76$, $p= 3.673 \times 10^{-07}$, Baby/Adult Chinese: $t(56)= 11.56$, $p= 2.2 \times 10^{-16}$, Baby/Adult Indian: $t(56)=9.37$, $p= 4.544 \times 10^{-13}$) (Fig. 3 B).

Notably, we observed more positive attitudes towards Arabic and Chinese Babies, which were preferred to Indian Baby faces; Caucasian Baby face ratings were significantly more negative than those given to Arabic baby faces, but did not differ from the scores obtained by Chinese and Indian Babies (Caucasian/Arabic Baby faces: $t(56) = -4.94$, $p = 7.316 \times 10^{-06}$, Chinese/Indian Baby faces: $t(56) = 3.02$, $p = 0.003761$, Arabic/Indian Baby faces: $t(56) = 3.57$, $p = 0.0007489$). Regarding the preferences towards adult faces, we found differences between all ethnic groups; Arabic faces were the most preferred, followed by Caucasian faces, then Indian faces and lastly Chinese faces (Caucasian/Chinese Adult faces: $t(56) = 7.82$, $p = 1.513 \times 10^{-10}$, Caucasian/Arabic Adult faces: $t(56) = -11.63$, $p = 2.2 \times 10^{-16}$, Caucasian/Indian Adult faces: $t(56) = 5.73$, $p = 4.159 \times 10^{-07}$, Chinese/Arab Adult faces: $t(56) = -11.43$, $p = 2.937 \times 10^{-16}$, Chinese/Indian Adult faces: $t(56) = -5.11$, $p = 4.083 \times 10^{-06}$, Arab/Indian Adult faces: $t(56) = 11.47$, $p = 2.497 \times 10^{-16}$). Interestingly, the two ethnicities that made up for the in-group were the ones judged more negatively, contradicting our expectation based on MEE.
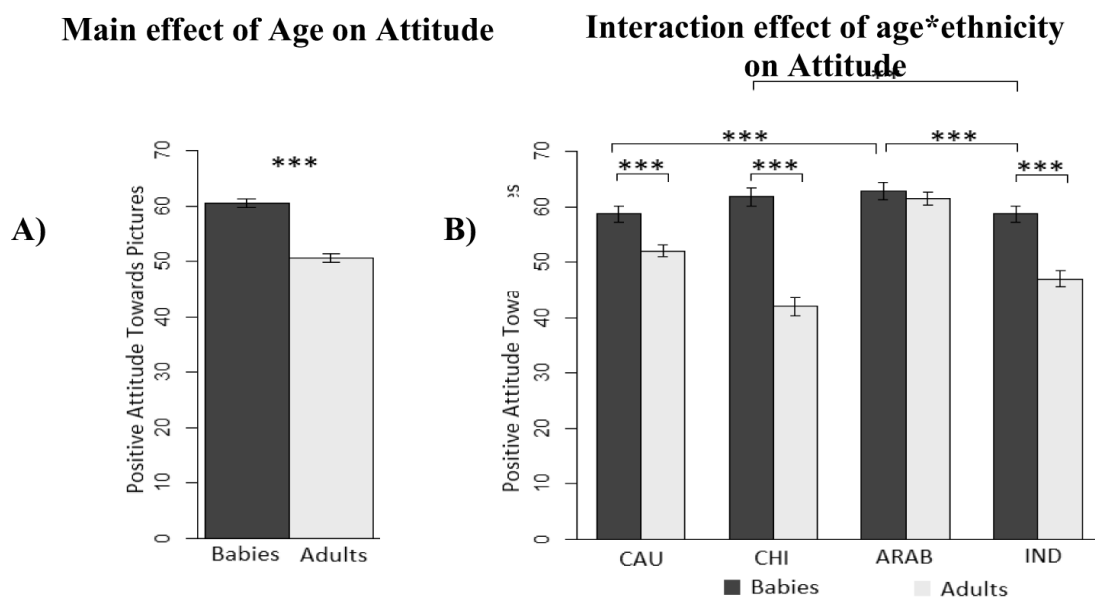

Fig. 3 A, B. Effects of faces' age and ethnic group on attitude scores in participants

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Physiological Results

The physiological results (i.e. pupil variation) were the following: Baby Chinese Left Pupil (M = -0.61; SD = 0.15); Baby Chinese Right Pupil (M= -0.61; SD = 0.12); Baby Caucasian Left Pupil (M = 3.02; SD = 0.37); Baby Chinese Right Pupil (M= -0.64; SD = 0.34); Baby Arabic Left Pupil(M = -0.67; SD = 0.27); Baby Arabic Right Pupil (M= -0.67; SD = 0.20); Baby Indian Left Pupil (M = -0.62; SD = 0.17); Baby Indian Right Pupil (M= -0.61; SD = 0.15); Adult Chinese Left Pupil (M = -0.62; SD = 0.20); Adult Chinese Right Pupil (M= -0.61; SD = 0.29); Adult Caucasian Left Pupil (M = -0.64; SD = 0.12); Adult Caucasian Right Pupil(M= -0.61; SD = 0.22); Adult Arabic Left Pupil (M = -0.60; SD = 0.10); Adult Arabic Right Pupil (M= -0.59; SD = 0.21); Adult Indian Left Pupil(M = -0.58; SD = 0.21); Adult Indian Right Pupil(M= -0.56; SD = 0.10).

Previous studies have highlighted that the right and left hemispheres process visual information differently, causing asymmetries in the pupil variation of the two eyes [44]. For that reason, we processed the data measured from the two eyes separately. We performed two $2 \times 4 \times 2 \times 2$ Analysis of Variance (ANOVA) with age and ethnicity of the stimulus as within-subject factors and gender and ethnicity of participants as between-subject factors.

As for behavioral results, we found no significant differences related to participants' gender; thus, data for males and females were combined during the subsequent analysis. Despite the previous results of Venturoso and colleagues (2019) and the well-documented knowledge that lateralization in visual processing affects pupil response, in our study we found the same pattern of pupil variation in the two eyes. Additionally, while Venturoso and colleagues (2019) observed both increases and decreases in pupil diameters with respect to the baseline, we found only pupil constrictions.

In both right and left pupil emerged a significant main effect of the ethnic group of face (left pupil: $F(3,165) = 5.98$, $p = 0.000677$; right pupil: $F(3,165) = 5.44$, $p = 0.00136$). More specifically, post-hoc analysis showed greater pupil constriction in response to Arabic faces compared to Indian faces (Arabic/Indian, left pupil: $t(56)= -4.03$, $p = 0.0001699$, Arabic/Indian, right pupil: $t(56)= -3.65$, $p = 0.0005698$; Fig. 4 A, B**)**.

Additionally, an interaction effect between ethnicity and age of the stimulus was found in both eyes (left pupil: $F(3,165) = 4.18$, $p = 0.00699$; right pupil: $F(3,165) = 6.98$, $p = 0.000189$). The subsequently performed t-tests pointed out a significant difference in how Baby and Adult faces were processed that was limited to only Arabic and Indian stimuli (left pupil, Baby/Adult Arabic: $t(56)= -4.97$, $p = 6.624 \times 10^{-06}$; left pupil, Baby/Adult Indian: $t(56)= -4.63$, $p = 2.209 \times 10^{-05}$; right pupil, Baby/Adult Arabic: $t(56)= -5.84$, $p = 2.791 \times 10^{-07}$; right pupil, Baby/Adult Indian: $t(56)= -4.54$, $p = 3.014 \times 10^{-05}$). Unexpectedly, significant discrepancies were found also in the response to Arabic baby faces, with greater constrictions for Arabic babies compared to Chinese and Indian babies. In the right pupil only, this difference was present also between Caucasian and Arabic baby faces (left pupil, Chinese/Arabic Baby: $t(56)= 3.47$, $p = 0.0010001$; left pupil Arabic/Indian Baby: $t(56)= -2.97$, $p = 0.004396$; right pupil, Chinese/Arabic Baby: $t(56)= 4.26$, $p = 7.996 \times 10^{-05}$; right pupil, Arabic/Indian Baby: $t(56)= -3.31$, $p = 0.001658$; right pupil, Caucasian/Arabic Baby: $t(56)= 2.74$, $p = 0.008184$). Taken together, these results partially contradict our predictions about the BSE: first of all, we found no significant difference between males and females. Secondly, we expected to observe a difference in pupil variations between Baby faces and Adult faces regardless of ethnicity and lastly, we did not predict the observed differences among Baby faces from different ethic groups.

Regarding Adult faces, post-hoc analysis showed that there were smaller pupil constrictions in response to Indian faces compared to Caucasian and Chinese faces in both eyes (left pupil,

Caucasian/Indian Adult: t(56)= -3.56, p = 0.0007692; left pupil, Chinese/Indian Adult: t(56)= -3.60, p = 0.0006802; right pupil, Caucasian/Indian Adult: t(56)= -2.74, p = 0.008263; right pupil, Chinese/Indian Adult: t(56)= -4.13, p = 0.0001229). No significant differences were found related to the participants' characteristics (sex and ethnic group).

Interaction effect age*ethnicity on left pupil   **Interaction effect age*ethnicity on right pupil**
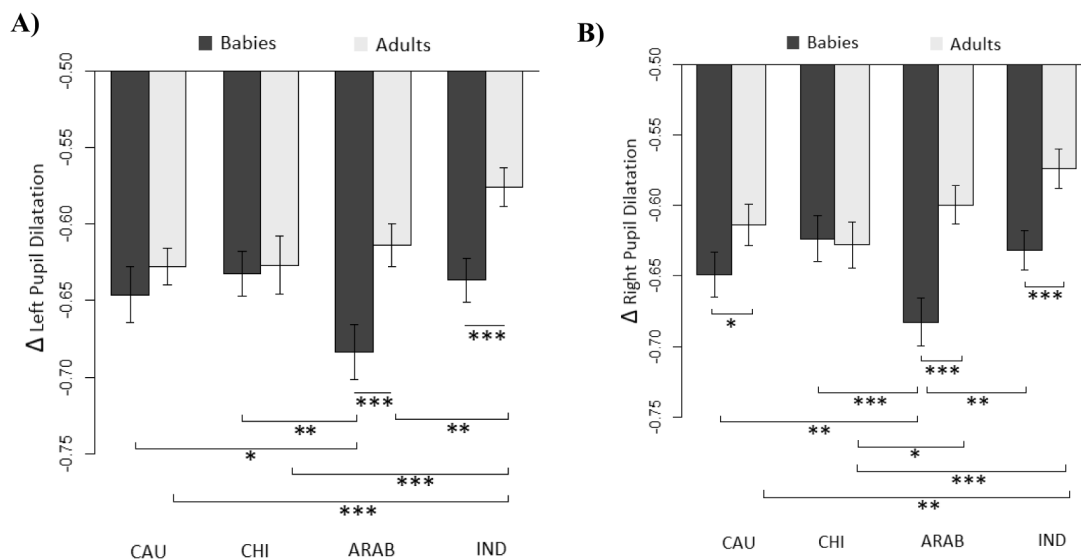

Fig. 4 A, B. Effects of the interaction between faces' age and ethnic group on the left and the right pupil width in participants

Discussion

With the present study, we aimed to further investigate the role and the interaction of two well-known phenomena — the Mere Exposure Effect and the Baby Schema effect — in face processing. To do so, we expanded the work of Venturoso and colleagues (2019), carrying out our research in Singapore, a cosmopolitan city-state where different ethnic groups coexist. This enabled us to observe if multiculturalism affects the way out-group faces are perceived. It is well-documented that facial features typical of children (included in BSE) motivate adults, especially women, towards protection and caregiving behaviors and allow child features to be considered "cuter" than adult features. Concerning MEE, it has been observed that familiarity increases the perceived pleasantness and likeability of objects, including faces. Since people from the same ethnic group share similar physical features, strangers belonging to one's ethnicity tend to look more familiar — and thus more attractive — than strangers from other groups. Yet, it is not clear how those two phenomena interact and modulate one another. The interaction of BSE and MEE has been investigated using both implicit (pupillometry) and explicit (questionnaires) measures. Results partially meet our predictions, providing interesting clues for further investigation.

Consistent with previous literature, participants showed more positive attitudes towards baby faces compared to adult faces, confirming the effect of BSE. We did not find a significant main effect of the participant's gender as we expected; this result is in line with other studies that point out that gender does not always influence BSE (Luo et al., 2011). Interestingly, post-hoc

analyses showed that BSE was present for faces of all ethnic groups, except for Arabic faces, where adults and babies received equally positive scores. The lack of BSE for Arabic stimuli might be due to the dimension of the sample, which might have been too small to find a significant difference. Another explanation might be the fact that the results reflect the ratings given by both female and male participants, who notoriously show larger MEE and lower BSE. Different interactions of the BSE and the MEE in males and females might have muddled the results, masking the BSE; enlargement of the sample and better stratification could lead to clearer results.

Regarding pupillometry analysis, we found greater pupil constriction in response to baby faces compared to adult faces in both pupils. This difference was found for Arabian, Caucasian, and Indian stimuli in the right pupil and for Indian and Arabic stimuli in the left pupil. Some studies have pointed out that early and transient pupil constriction happens in response to attractive visual stimuli, and the magnitude of the constriction is related to its perceived pleasantness [31]. As for attitude, those differences might be related to the dimension of the sample or the fact that results are affected by the scores given by both genders. Also, Venturoso and colleagues (2019) found greater pupil constrictions in response to in-group babies than adults, which have been interpreted as an increase of attention toward the visual stimuli. On the other hand, they found that out-group babies elicited a wider pupil dilation. The fact that, unlike Venturoso and colleagues (2019), we found a decrease in pupil diameter for both in-group and out-group babies might be due to the fact that participants of our study have more familiarity with people from other ethnic groups and for that reason, the role of ethnicity in determining pupillary response is mitigated. These results are consistent with the idea that exposure to people from other ethnicities reduces in-group favoritism [56]. Taken together, results suggest that there is an interaction between BSE and the ethnic group of the stimuli; interestingly it would seem that familiarity (MEE) with out-group individuals reduces the differences in the responses towards in-group and out-group faces.

Regarding explicit attitudes towards adult faces, we found significant differences among all ethnic groups, while for babies differences were observed only between Arabic/Caucasian babies and Arabic/Indian babies. Arabic adults were the most liked, followed by Caucasians, Chinese, and Indians. These results suggest that where BSE is not present, the effect of ethnicity is stronger. Interestingly, the two face categories that represent the in-group of our participants (Chinese and Indian) are the ones that received the most negative scores. It is possible that the greater familiarity of Singaporean participants with different ethnicities has enabled them to rate faces according to their personally held attitudes and preferences, regardless of ethnic appearance [55, 56]. At the current state of knowledge, we have no clear explanation for the preference towards Arabic faces found both for adult and Baby pictures. The fact that the favoritism was seen in both age-groups suggests that it is not due to a greater attractiveness of the specific stimuli presented (that is, the faces presented were more beautiful than the average); on the contrary, probably it reflects an attitude towards the Ethnic Group. An enlargement of the sample and a deeper understanding of participant's experiences, preferences and believes might help to uncover the causes of the preference towards Arabic faces.

Physiological results confirm that the way faces are processed is related to the ethnicity but not necessarily to in-group/out-group bias; in fact, significant differences in pupil constriction were found not only between Caucasian/Indian, Arabic/Indian, and Arabic/Chinese adult faces but also between Indian/Chinese (both in-group) and Caucasian/Arabic (both out-group) adult faces.

We found no clear correlation between the explicit attitude towards a certain ethnicity and the pupillary response; enlargement of the sample and a better stratification might be able to

cast a clearer light on the complex interaction between ethnicity, familiarity, and personally held attitudes on face processing.

Limitations

Some of the hypotheses that we advanced were not fully confirmed by our results, probably because of some limitations our study suffers from. Here we report them, proposing possible future directions for research in this field.

First of all, our sample was modest (35 participants), and its composition was not perfectly balanced with regard to participant characteristics (gender and ethnic group). It would be desirable to expand it, paying particular attention to the creation of a sample where all factors and their possible combinations are equally represented (Chinese males, Chinese females, Indian males, Indian females). Secondly, we conducted our study in Singapore to assess the effect of mere exposure on face processing in a multicultural country. We recruited only Singaporean participants, assuming that they would have been exposed to people from different ethnic backgrounds. Therefore, we did not have further information about how participants interacted with people from other ethnic groups and their attitude towards them. For future inquiry, researchers should take into account experiences and personal opinions towards out-group members. This recommendation should be applied also to the effect of Baby Schema; in fact, we required participants to be non-parents, but we did not investigate their individually held attitude towards babies nor if they have had caregiving experiences. Thirdly, the interpretation of pupil diameter's variation is not always univocal; for that reason, we suggest using other techniques besides pupillometry to measure the direct/indirect brain response to visual stimuli (e.g., EEG).

Lastly, it might be interesting to present stimuli with different characteristics; more specifically, we used only female adult faces and all stimuli had a neutral expression. Future studies could investigate the responses to male adult faces and stimuli showing different emotions.

Conclusions

Our study aimed to enrich the knowledge about face processing. Faces are visual and social stimuli that convey an enormous amount of information and, depending on the situation and the observer, assume different valences and relevance.

Here we have presented a follow-up of Venturoso colleagues' (2019) research, examining in-depth how BSE and MME interact in a context where people are exposed daily to individuals from other ethnicities.

Our results confirm the influence of BSE in face processing, which evokes in both males and females a more positive attitude and a stronger pupillary response. We observed that BSE is modulated by the ethnicity of the stimuli regardless of participant gender, possibly because males' and females' responses were processed together, or because the sample was too modest.

As for adult faces, we found that ethnicity influences their pleasantness and the way they are processed. Interestingly, differences between ethnicities were not determined by their belonging to the in-group or out-group. This finding suggests that familiarity with individuals from other ethnic groups (thus the MME) influences the way faces are explicitly and implicitly perceived. In-group and out-group differences found in previous studies probably partially reflect discrepancies in familiarity with the stimuli; multiculturality and exposition to other ethnicities seem to modulate those differences.

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