DOES THE THATCHER EFFECT EXTEND TO INFANT FACES?

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Abstract

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Decades of research on the mechanisms of face processing have demonstrated that humans rely heavily on configural processing strategies when viewing faces. However, this work has been done using almost exclusively adult facial stimuli. More recently, researchers have proposed that infant faces may elicit different neural activity and behavioral responses than adult faces. These observed differences may start at the very early stages of face processing (i.e., the structural encoding occurring within 200ms of seeing a face). However, no studies to date have explored potential differences in processing strategies used for infant faces compared to adult faces. The current study uses a well-established configural disruption known as the Thatcher Effect (TE) to investigate the use of configural processing for infant faces.

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Table of Contents

List of Tables

List of Figures

Introduction

Face processing is perhaps the most exceptionally developed visual skill in humans (Caharel et al., 2006; Haxby et al., 2000; Maurer et al., 2002; Mondloch et al., 2003). As adults, we have developed an extraordinary capacity of achieving expertise – with the ability to recognize hundreds of individual faces despite multiple configurations and complexity of features – accurately analyzing and deciphering specific cues including face and head orientation, direction of gaze, distance between eyes, and emotional expressions with great ease and reliability (Bhatt et al., 2005; Carey & Diamond, 1977; Diamond & Carey, 1986; Haxby et al., 2000; Maurer et al., 2002; Mondloch et al., 2003; Pascalis et al., 1995; Rhodes et al., 2002; Schwaninger et al., 2003; Schwarzer et al., 2007; Slater et al., 2000).

Most of what we know and understand about face processing has been studied extensively using young, adult faces. However, research suggests that both neural and behavioral responses to infant faces differ from those for adult faces (Brosch et al., 2007; Kringelbach et al., 2008; Hodsoll & Hodsoll, 2010; Proverbio et al., 2011). There is an adaptive function to these differential responses to infants given the importance of evoking parental instinct, responsivity, and care (Lorenz, 1943). However, it remains unclear whether these differential responses are due to differences in the early mechanisms of face processing or later affective processing.

Mechanisms of Face Processing

There are two types of information used for face processing, memory, and recognition: featural information and configural information (Carey & Diamond, 1977;

Rhodes, 1988; Maurer et al., 2002; Rakover, 2002). Featural information is information held in the individual facial parts such as the colors of the eyes, shape of the mouth or nose, or the contours of the cheekbones (Bombari et al., 2009; Carey & Diamond, 1977; Schwaninger et al., 2003; Sergent, 1984). The processing of this internal information is referred to as ‘featural processing’ (also referred to as ‘component processing’, or ‘piecemeal or part-based processing’ in the literature). Configural information is information about the spatial relations among the face parts, including the distance between the eyes or the distance from nose-to-mouth (Bruce, 1986; Leder & Bruce, 2001; Maurer et al., 2002; Sergent, 1984; Schwaninger et al., 2003). The processing of this spatial-relational information is referred to as ‘configural processing’ (also referred to as ‘holistic processing’ in the literature). Although faces are processed by utilizing both featural and configural information (e.g., Rhodes, 1988), studies have consistently shown that adults tend to rely more heavily on configural processing strategies for face perception across a variety of tasks (Farah et al., 1998; Tanaka & Farah, 1993; Tanaka & Sengco, 1997).

Configural Processing

Configural processing relies on sensitivity to first- and second-order relational information and holistic processing of that information (Mauer et al., 2002). First-order relational information refers to basic featural arrangements of face parts (i.e., faces have two eyes above a nose above a mouth; Carey & Diamond, 1977; Maurer et al., 2002). Even newborns can detect first-order features of the face and demonstrate strong visual preferences for these face-like configurations (Diamond & Carey, 1986; Fantz, 1961;

Mondloch et al., 1999; Simion et al., 2001). Second-order relational information refers to specific spatial inter-relations among facial features such as distance between the internal facial features (Carey & Diamond, 1977; Mauer et al., 2002). All faces share the same first-order relations, so these second-order relations are particularly important for individuating faces. Then, we tend to engage in holistic processing of this information, processing the face and its features in a Gestalt[1]-based fashion such that it becomes difficult to parse the face into isolated features (Scott & Nelson, 2006; Tanaka & Farah, 1993). For example, Tanaka and Farah (1993) found that when faces were viewed holistically (e.g., whole; global), isolated parts of the face were more difficult to recognize, whereas face components (e.g., mouth) displayed in isolation were recognized with great ease.

Expertise and Configural Processing

Because humans spend more time looking at faces than any other object category (Haxby, 2000), we are considered "face experts" and there is strong evidence to support the claim that expertise with a particular object category leads to an increased reliance on configural processing. The most striking evidence for this comes from studies of individuals who are experts with a stimulus class other than faces. Initial work in this area used 'Greebles' – a homogeneous set of non-face stimuli with individuals, genders, and families represented across the stimulus set (Gauthier & Tarr, 1997; see Figure 1). Gauthier and Tarr (1997) demonstrated that configural processing increases with

[1] A 'Gestalt' is a symbolic configuration of pattern of elements greater than the sum of its parts.

expertise using these Greebles. Compared to novices, Greeble experts (i.e., individuals trained over several days to recognize individuals within the stimulus set) were more sensitive to changes in configural information contained in the stimuli (Gauthier et al., 1998; Gauthier et al., 2002). Similarly, car enthusiasts (who have expertise with car models) have been found to use more configural processing when viewing cars than car novices (Gauthier et al., 2003) and dog experts have been found to use more configural processing when viewing dog faces than novices do (Diamond & Carey, 1986).

Figure 1

Greebles, A Homogenous Set of Non-Face Stimuli

Additional evidence for the role of expertise comes from studies of the development of face processing in children. Carey and Diamond (1994) found that younger children were quite susceptible to featural disruptions (e.g., adding a mustache to a face) and appear to rely more heavily on featural processing than configural processing strategies. However, around age 10 children switched to a reliance on configural processing due to the development of expertise with faces. This expertise leads to an increased reliance on configural processing for face perception.

Research on the other-race effect (ORE) has further emphasized the effects of expertise, evident even within the wider object category of "faces". The ORE refers to the well-documented finding that humans are experts at recognizing and remembering faces of their own-race compared to faces of another race (Chance & Goldstein, 1996; Hahn et al., 2012; Hayden et al., 2007; Meissner & Brigham, 2001; Michel et al., 2004; Michel et al., 2006) compared to non-face-like object recognition (Hayward et al., 2007; Meissner & Brigham, 2001). Previous literature has established that people have more experience at facial recognition of own-race faces than other-race faces (Bothwell et al., 1989; Brigham & Malpass, 1985; Chiroro & Valentine, 1995; Tanaka et al., 2004).

For example, Rhodes and colleagues' (1986) measured the inversion effect on own-race (high expertise) and other-race (low expertise) faces for both European and Chinese subjects in reaction times for recognition. All subjects had some experience and familiarity with other-race faces of all racial groups with which expertise of unfamiliar groups could occur. The researchers predicted that such facial encoding was only possible for subgroups of faces with which individuals were already experts. Each race face set were assessed in an upright orientation and inverted orientation, with all face stimuli displayed in an upright orientation intended to measure how upright faces were encoded. The results revealed significant main effects of face race and race of subject, with European subjects responding and recognizing at a faster rate than Chinese subjects. Additionally, there was a significant main effect of orientation and an effect of orientation and subject race, with upright faces recognizing more rapidly than inverted faces, displaying a larger inversion effect with the Chinese subjects than European subjects. There was a three-way interaction between subject race, face race, and orientation results, supporting the researchers' previous predictions that there would be a larger inversion effect for own-race faces than other-race faces, however, the effect was weaker for European subjects (Rhodes et al., 1989).

The researchers hypothesized that expertise linked with higher use of configural cues would be connected to large inversion effects. Expertise was hypothesized to have large inversion effects associated with advanced applications of configural cues, with expertise associated with greater recognition performance. Yet, both groups performed far superior to European faces than Chinese faces, suggesting that European faces may be more heterogenous than Chinese faces. Another likelihood is that the Chinese subjects gained expertise with European faces during their short residence in New Zealand which may have diminished their own-race advantage. The results revealed that inversion had a larger effect in own-race faces suggesting that people relied heavily on configural processing for own-race faces. However, it is not race per se that determined this reliance on configural processing – rather, expertise allows humans to adapt to their environments in which they learn to process the familiar faces around them more effectively than unfamiliar faces less available to them. Most people will have more exposure to, and thus experience with, faces of their own race.

Supporting this, a study by Tanaka and colleagues (2004) focused on holistic face processing and encoding aspects of own-race advantage in a part-whole task, where there were minimal memory demands given to the participants who were asked to recognize facial features of Caucasian faces and Asian faces presented in both isolation and as a whole face. The results showed that Caucasian participants recognized own-race faces more holistically than Asian faces. Asian participants displayed holistic recognition for both own-race faces and other-race faces, suggesting that the own-race effect may occur from holistic recognition of faces from a highly familiar racial group, rather than own-race advantage. These results suggest that encoding and recognizing own-race faces and other-race faces are equally affected by the daily lives, consistent interactions, and familiar exposures of the viewer (Tanaka et al., 2004). These results reveal that while the group of Asian immigrants residing in Canada ethnicity is Asian, their experiences with faces were similar to those of the Caucasian participants. Thus, it is not ethnicity alone that determines the reliance on configural processing, rather, humans are able to adapt to their environment where they learn to process the familiar faces around them more effectively than the unfamiliar faces less available to them. Most people usually have more exposure to, and thus experience with, faces of their own ethnicity.

Configural Disruptions

Configural disruptions appear to be particularly detrimental to face processing. When there is a disruption in configural processing, the relationship between internal and external facial features becomes less noticeable and increasingly more difficult to detect local changes (Rock, 1988).

The Face Inversion Effect

Objects, especially faces, usually viewed in one orientation turned upside down becomes increasingly difficult to identify and recognize. Orientation plays a significant role in face processing because faces are significantly more difficult to process when inverted (Yin, 1969). When a face is inverted, the global configuration is distorted, such as the eyes are no longer above the nose and mouth (Rhodes et al., 1993; Rossion et al., 2000; Tanaka & Farah, 1993). Compared to other mono-oriented stimuli (e.g., airplanes, houses), configural disruption in faces showed a larger decline to orientation in inversion and decreased recognition rates (Yin, 1969; Rhodes et al., 1993; Tanaka & Farah, 1993). Perhaps the most cited example of this is the Face Inversion Effect (FIE), which occurs when recognizing faces (compared to other objects or non-face stimuli) takes a disproportionately longer time when inverted, as opposed to when upright (Bartlett & Searcy, 1993; Boutsen & Humphreys, 2003; see Yin, 1969 for review).

In the seminal study on the FIE, Yin (1969) showed participants upright and inverted photographs of faces, houses, and other stimuli in the same orientation as subjects investigated those stimuli in a forced-choice recognition paradigm. The results indicated that upside-down faces were comparatively more difficult to recognize than other inverted objects and attributed to the inversion effect (Yin, 1969, 1970). Configural disruption is more impaired in face perception than object perception and non-face stimuli due to relying more heavily on processing individual features (Richler et al., 2011). Other studies on the inversion effect have shown that configural disruption occurs when using line-drawn faces (Yin, 1969, 1970), isolated features (Richler et al., 2011), and both familiar and unfamiliar faces (Scapinello & Yarmey, 1970; Yarmey, 1971). Yin’s (1969) study proposed that the cause of the FIE was an unspecified special face component while Diamond and Carey’s (1986) study suggested that a special kind of higher-order information (also known as ‘configural information’) was needed to develop expertise. Diamond and Carey's (1986) study suggested that the FIE occurs because of second-order relational features and hypothesized that face recognition is distinct from other object recognition that relies on second-order properties (Diamond & Carey, 1986; Tanaka & Farah, 1991).

The Thatcher Illusion

Another widely used configural disruption is the "Thatcher Illusion", also known as the "Thatcher Effect" (TE), an orientation-sensitive face processing illusion, which provides a fascinating example of the perceptual consequences of face inversion. The Thatcher Illusion was first defined and detected in a study by Thompson (1980), where face content was transformed from regular (normal, original, unedited) to bizarre while keeping its local features relatively unchanged. The study used a photograph of former UK Prime Minister Margaret Thatcher by changing the orientation of facial features and altering the configuration of the eyes and the mouth to the point of "grotesqueness", characterized as a repulsive, incongruous distortion of appearance (Thompson, 1980).

The Thatcher Illusion is a phenomenon where it becomes increasingly more difficult to perceive the local featural changes when upside down (inverted), despite identical changes becoming immediately evident when shown in an upright orientation (Kemp et al., 1990; Leder et al., 2001; Mestry et al., 2014; Rhodes, 1993; Schwaninger et al., 2013; see Thompson, 1980 for review). When the eyes and mouth are turned upside-down proportionate to the rest of the face, a disruption known as "Thatcherization" (when facial expressions appear "grotesque", "bizarre") occurs. This distortion of the face is immediately perceived when faces are shown in an upright orientation and instantly perceived as “bizarre” (i.e., “grotesque”) and easily noticeable (Carbon & Leder, 2005; Psalta et al., 2014). However, when the image is inverted, the face does not register the same bizarreness and is no longer recognizable or visible (Psalta et al., 2014).

Researchers (Boutsen & Humphreys, 2003; Rock, 1988) have proposed that Thatcherization occurs in configural but not in featural processing, indicating that inversion to face processing is not impaired. According to these researchers, in an upright orientation, the face creates a grotesque or bizarre expression, one that is easily noticeable and recognized when viewed in a holistic manner (e.g., as a whole, global). During inversion, it becomes increasingly more difficult to recognize a face and encode facial expressions, so global inversion of a Thatcherized face limits the perception of a grotesque (or bizarre) expression (Bartlett & Searcy, 1993; Muskat, 1997).

Mestry and colleagues (2014) examined inversion and Thatcherized faces (conditions of no features and Thatcherized features) on a set of event-related potential (ERP) factors and found that individuals with acquired prosopagnosia could differentiate between Thatcherization (i.e., configural disruption) and typical faces but could not distinguish or classify the illusion. Therefore, the Thatcher Illusion is often interpreted as resulting from identifying a configural distortion of information when “Thatcherized” faces are upright but not when inverted (Mestry et al., 2014; Thompson, 1980). When faces are upright, it is easily recognized and distinguishable, but when faces are inverted, it becomes increasingly difficult to accurately recognize the facial features.

Carbon and colleagues (2007) studied faces as objects of non-expertise and processing of Thatcherized faces in congenital prosopagnosia (cPA), a severe visual facelearning and recognition disorder with difficulties in recognizing familiar faces. The researchers used Thompson's (1980) Thatcher Illusion as a test of configural processing of reaction time using a rapid grotesqueness decision task with Thatcherized faces to determine whether the amount of configural processing was decreased with a group of people with cPA and a group of matched control participants. From early childhood, those with cPA stated medium to severe losses in recognizing familiar faces (Carbon et al., 2007). Participants were asked to perform a paper-and-pencil test showing twenty famous people, then asked to evaluate the names and faces in a separate test, calculating reaction times and rotation degrees. Two versions of the photographs were shown, one showing a full face, and the other showing only the interior facial features (e.g., inner face). The study additionally looked into whether the Thatcherized faces appeared grotesque or not grotesque. Participants performed superbly in analyzing the grotesqueness levels in original faces compared to the rotation degrees. The error rates for Thatcherized faces slowly increased when at a degree of 0 to 90 and sharply at 180 degrees. Results revealed little to no deficiency in recognizing familiar people and faces compared to the soaring performance of familiar name recognition. The results indicated that processing faces as objects of non-expertise at high levels showed configural disruption when processed at even higher rotating angles typically predicted for objects of expertise (Carbon et al., 2007).

Infant Faces Are Special

Several lines of research have suggested that infant faces may be processed differently than adult faces (Brosch et al., 2007; Kringelbach et al., 2008; Proverbio et al., 2011; Thompson-Booth et al., 2014). Given that infant face morphology is distinctly different than adult face morphology (Enlow & Hans, 1996), infant face processing may not be the same as adult face processing. Indeed, studies have shown that infant faces capture our attention more readily than adult faces (Brosch et al., 2007; Cárdenas et al., 2013) and they evoke different behavioral and neural responses (Carbon et al., 2005; Hahn et al., 2016). Several neuroimaging studies have indicated that there is enhanced processing at early and late stages of face perception for infant faces as compared to adult faces (Hahn et al., 2016; Kringelbach et al., 2008; Proverbio et al., 2011). A study by Kringelbach and colleagues (2008) using magnetoencephalography (MEG), suggested that the differences in processing infant and adult faces may be due to enhanced frontal brain activity.

While it is clear that the processing of adult and infant faces may not be identical, relatively little work has been done to determine how the processing of these two face categories differs. It is possible that differences emerge at the early visual processing stages for these face types and the use of configural processing may vary. If so, infant faces may not be susceptible to configural disruptions to the same extent as adult faces.

While there have not been any direct tests of configural processing for infant faces, there have been several studies that have explored the ORE for infant faces. Given that the ORE is thought to develop as a result of expertise and configural processing is linked to expertise, these studies may reveal potential differences in the use of configural processing strategies.

Studies that have investigated the ORE in infant faces using attentional paradigms have shown conflicting results – with some finding evidence for an ORE in infant faces while others do not. Hodsoll and colleagues (2010) investigated this using South Asian and Caucasian infant and adult faces (viewed by participants of South Asian or Caucasian ethnicity) using the dot probe task. The results showed that own-race infant faces attracted attention more so than other-race infant faces, thus, providing evidence for an ORE in infant faces. Conversely, Proverbio and colleagues using a Posner cueing task have not found evidence for an ORE in infant faces across several studies using Caucasian participants (2011, 2019). Their results suggest that adult viewers' attention is automatically captured by infant faces regardless of ethnicity. Interestingly, Martinez and colleagues (2020) found no evidence of an ORE for infant faces using an attentional task but did find an own-race bias for memory performance with black and white infant faces.

Additional work using electroencephalography (EEG) has also found equivocal evidence for different neural responses to own-race and other-race infants. Across multiple studies, Proverbio and colleagues (2019, 2020) reported no differences in brain responses to infant faces of own- and other-ethnicities. In line with this finding, Raghunath and colleagues (2022) showed no differences in brain activity for parents viewing own-ethnicity and other-ethnicity infant faces using fMRI. However, Spencer and colleagues (2018) found enhanced N170 responses (thought to reflect configural processing) for outgroup compared to ingroup children's faces.

The Current Study

The current study determined whether infant face processing relies on configural information to the same degree as adult face processing. To explore this issue, the Thatcher Effect (TE), a configural disruption, was measured for adult and infant faces shown in both an upright and inverted orientation. Because the TE is a well-documented orientation-dependent effect (Chance & Goldstein, 1996; Hayden et al., 2007; Meissner & Brigham, 2001; Michel et al., 2004; Michel et al., 2006), I predicted that the magnitude of the Thatcher Effect will be much larger when faces are shown in an upright orientation compared to inverted (i.e., a significant main effect of orientation in the ANOVA analysis described below).

With regards to differences in the TE for adult and infant faces, the previous literature is mixed, with some studies providing evidence that the processing of infant faces may not rely as strongly on configural information (Martinez et al., 2020; Proverbio et al., 2011; Proverbio & De Gabriele, 2019; Proverbio et al., 2020) and others suggesting infant faces are processed similarly to adult faces (Hodsoll et al., 2010). If infant faces are processed similarly to adult faces, I would expect no effect of face type; however, if infant faces are processed differently than adult faces an effect of face type may emerge.

The critical prediction, however, is that of the interaction between face type and orientation. Following the logic of Proverbio's (2011, 2019, 2020) work demonstrating that infant faces are not susceptible to the other-race effect and therefore may be processed using less configural information, I predicted that the magnitude of the TE was greater for adult faces than infant faces when shown upright (because the TE is orientation-dependent). If, however, the processing of infant faces is just as reliant on configural information then I would predict that adult and infant faces would be equally impacted by the Thatcher manipulation and there would be no differences in the magnitude of the TE for these two face types.

Method

Participants

An *a priori* power analysis using G*Power, based on previous studies of the Thatcher Effect for adult faces, indicated that a minimum of 40 participants were required for this study. Participants were recruited online from the Psychology Department Research Participant Pool via SONA systems and participants completed the study online via the BERL website (www.facelab.humboldt.edu). One hundred and nineteen participants were recruited. There were no restrictions based on age, gender, or ethnicity during participant recruitment. Participants ranged in age from 18.1—59.8 years (*M* = 23.25, *SD* = 7.07). The sample was comprised of 87 women (73%), 22 men (18%), and 9 non-binary (8%) individuals (1 participant did not disclose their gender). The sample was ethnically diverse (see Table 1), with the majority of the sample being white (54%) or Latinx (29%). Within the sample, 9 participants (8%) reported that they were a parent, while the remaining 110 participants (92%) reported not having children. All participants provided informed consent prior to beginning the study.

Table 1

Reported Participant Ethnicity (total N = 119)

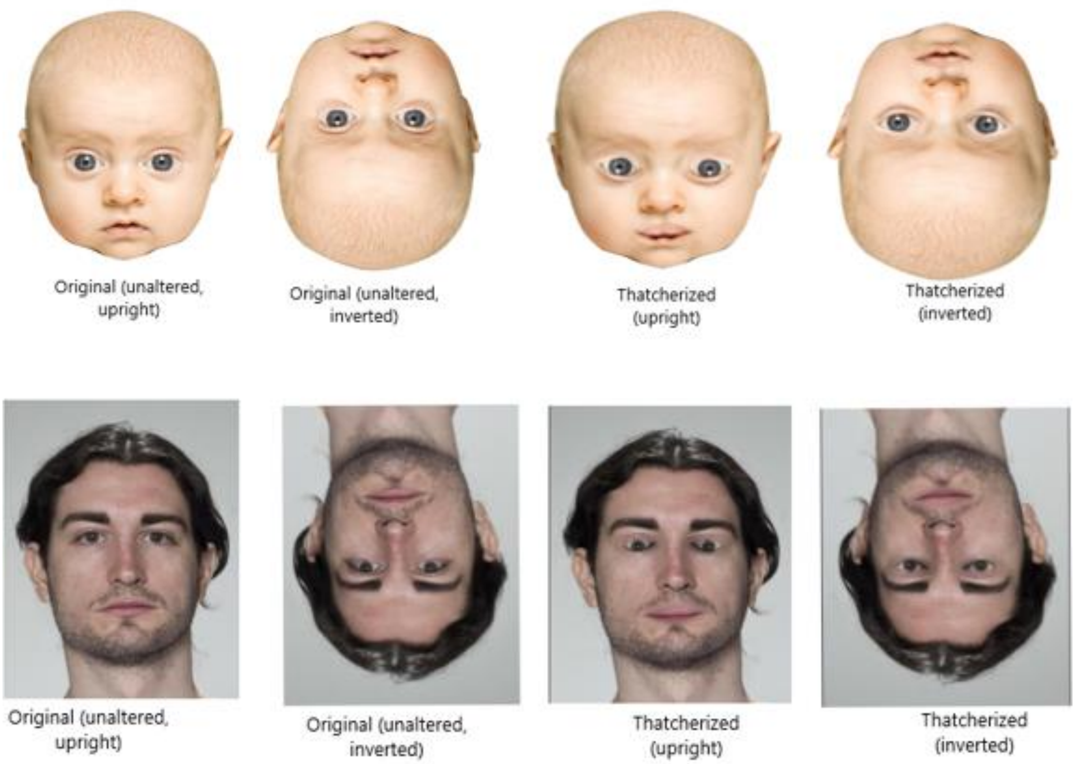
	African	Arabic	East Asian	Latinx	Mixed	Native American	Other	White	Not disclosed
N	2	3	2	34	10	2	1	64	1

Stimuli

The stimuli consisted of 30 white adult face identities and 30 white infant face identities. The adult face images were obtained from the Face Research Lab London Set (DeBruines & Jones, 2017) which included individuals aged 18 to 35 years old. The infant face images were obtained from various online sources (e.g., Google image search for infant faces) and selected based on obtaining the highest degree of standardization possible (e.g., head-on shot, even lighting, full face visibility, neutral emotional expression, closed mouth, and face free of adornments or food). All infant face identities (experimenter-identified) appeared to be under 24 months of age (although it is not possible to confirm given online image collection). For each identity, a normal unedited version and a Thatcherized version were used in both an upright and inverted orientation. The total number of stimuli was 60 (identities) * 2 (Thatcher manipulation) * 2 (orientation) = 240 stimuli. The GIMP imaging editing software was used to create the Thatcherized versions of each face; the eyes and mouth were rotated 180 degrees and then the manipulated regions were blended to ensure that the features were a natural part of the face (see Figure 2).

Figure 2

An example of an original unaltered and Thatcherized infant face (top row) and adult face (bottom row) in the upright and inverted orientation.



Measures

Demographics

Participants completed a brief demographic survey at the start of the study. They were asked to report their age, biological sex, ethnicity, and parental status.

Thatcher Effect Scores

During the main study, participants were asked to rate how bizarre each face looked on a scale of 1 (*not very bizarre*) to 7 (*very bizarre*). Because Thatcherization causes faces to appear bizarre, these bizarreness ratings could be interpreted as an index of configuration disruptions caused by Thatcherization. Following previous research (Anes & Short, 2009; Mondloch et al., 2004; Murray et al., 2000; Talati et al., 2010), a Thatcher Effect (TE) score was calculated for each participant for the upright adult, upright infant, inverted adult, and inverted infant face categories by subtracting the bizarreness rating for the normal face from the Thatcherized face for each stimulus. Therefore, higher TE scores indicate a greater configural disruption.

Procedure

This study was approved by the IRB at Cal Poly Humboldt (IRB # 17-065). Upon signing up through SONA systems, participants received a study link and were directed to the BERL website. Participants were required to provide informed consent prior to the beginning of the study. They then completed the demographic survey followed by the rating task. During the rating task, participants were presented with each of the 240 faces and asked to rate how bizarre each face looked. Faces remained on the screen until a rating was made. The study lasted an average of 18.4 minutes (*SD* = 14.7). The adult and infant faces were presented in blocks and the order of first presentation was counterbalanced across participants so that half rated the infant faces followed by the adult faces and the other half rated the adult faces followed by the infant faces. Order of stimulus presentation within each block was fully randomized. Participants were debriefed after the completion of the study and compensated with course extra credit at the discretion of individual instructors via the SONA system.

Results

Preliminary Analysis

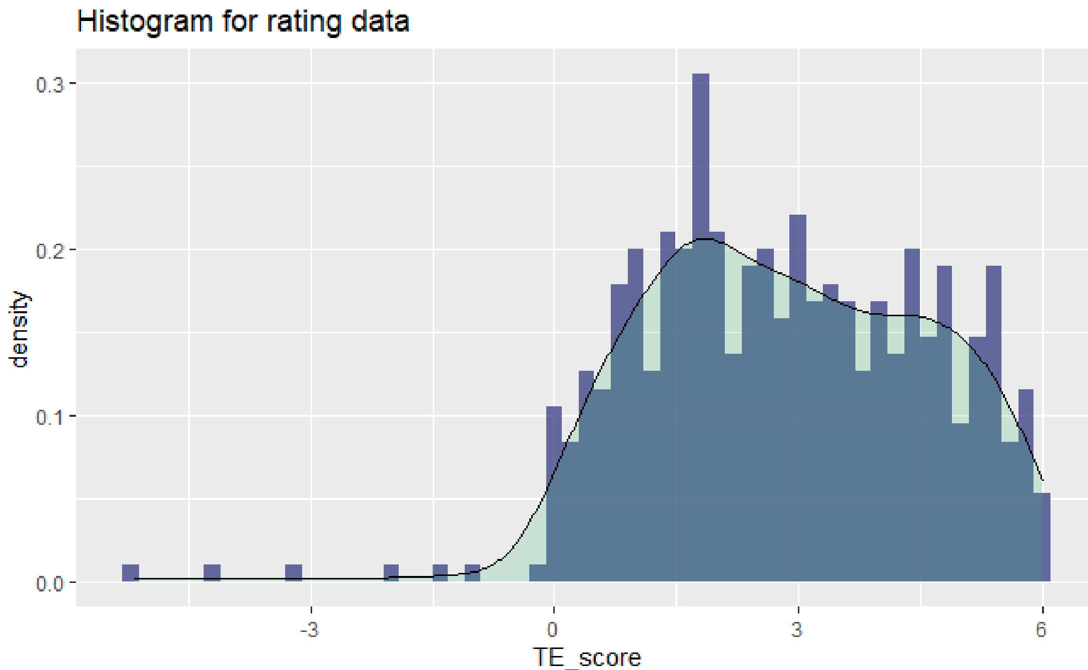
All analyses were performed using R. The Thatcher Effect (TE) scores described above were used as the dependent variables for the analysis reported here. Face orientation, face type, and parental status were included as independent variables in the analyses reported here. Thatcher Effect scores ranged from -5.2 – 6.0 ($M = 2.8$, $SD = 1.7$) across the four face categories. A Shapiro-Wilk test indicated that the data were not normally distributed ($p < .001$). As seen in Figure 3, the data were negatively skewed. However, because ANOVA is robust to non-normally distributed data, the results reported here reflect the analysis of the full dataset. The analysis was repeated removing outliers (i.e., participants with TE scores more than 3 *SD* from the mean, $N = 2$) to confirm the pattern of results reported was not impacted by these extreme values. This analysis confirmed the same pattern of results were present with these outliers removed.

Main Analysis

A 2 X 2 analysis of variance (ANOVA) was conducted on the TE scores using the ezANOVA package with orientation (upright/inverted) and face type (adult/infant) as within-subject factors. A sensitivity analysis (performed using the pwr2ppl package) indicated that a sample of 119 gives a power of 1 to detect effects as small as .27 for orientation, a power of .23 to detect effects as small as .003 for face type, and a power of .13 to detect effects as small as .002 for the interaction between these two factors.

Figure 3

A Histogram Showing that Data is Skewed and Not Normally Distributed



As predicted, the analysis revealed a significant main effect of orientation, $F(1,118) = 345.80$, $p < .001$, $\eta^2G = .27$ (see Figure 4), such that TE scores were significantly larger for faces in the upright condition ($M = 3.73$, $SD = 1.64$) compared to the inverted condition ($M = 1.92$, $SD = 1.32$).

There was a trend for the effect of face type although this failed to reach statistical significance, $F(1,118) = 3.86$, $p = .052$, $\eta^2G = .003$. As seen in Figure 5, this suggests that the TE scores were slightly larger for the adult faces ($M = 2.91$, $SD = 1.76$) compared to the infant faces ($M = 2.75$, $SD = 1.73$).

Importantly, these main effects were qualified by a significant interaction between face type and orientation, $F(1,118) = 5.12$, $p = .025$, $\eta^2G = .002$ (see Figure 6). Post-hoc pairwise *t*-tests (Bonferroni corrected) comparing TE scores for adult versus infant faces in each orientation indicated that the TE was larger for adult faces ($M = 3.87$, $SD = 1.60$) than infant faces ($M = 3.59$, $SD = 1.67$) in the upright orientation, $t(118) = 2.53$, $p_{adjusted} = .01$), but not the inverted condition, $t(118) = .59$, $p_{adjusted} = .56$, $M_{adult} = 1.95$, $SD_{adult} = 1.34$, $M_{infant} = 1.90$, $SD_{infant} = 1.32$.

Figure 4

A Significant Main Effect of Orientation on the TE Scores for Upright Faces

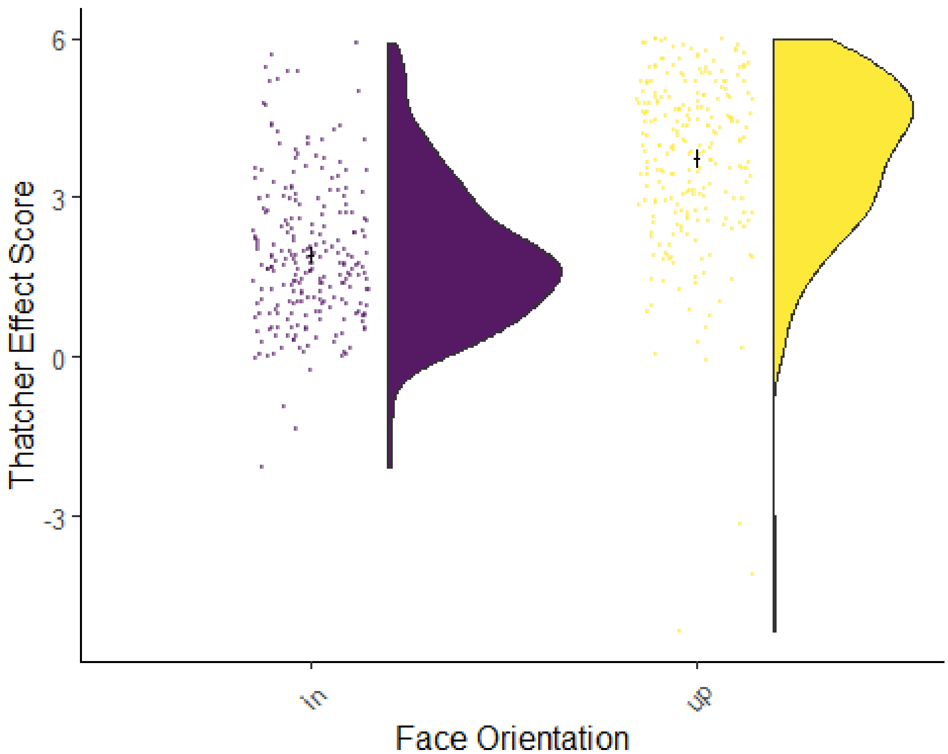


Figure 5

A Trend for the Effect of Face Type

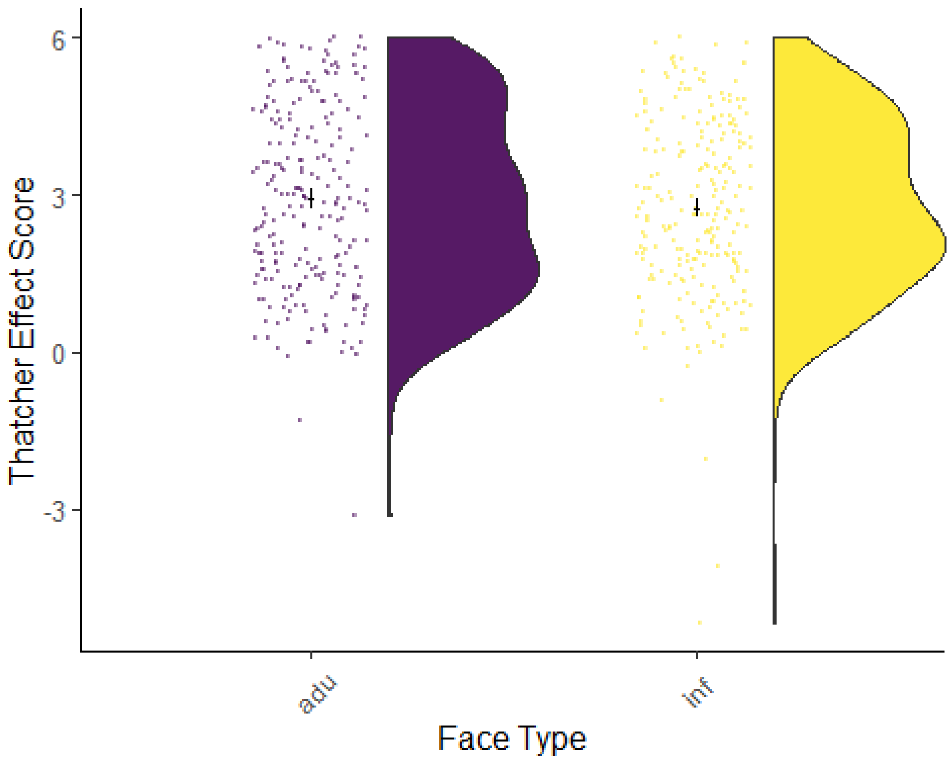
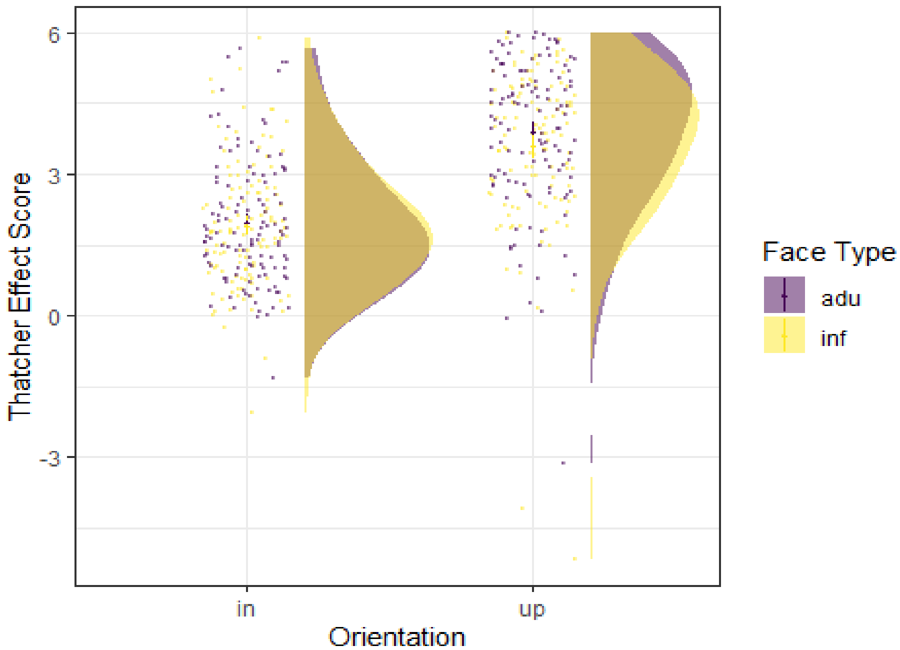


Figure 6

A Significant Interaction Between Face Type and Orientation on the TE Scores



Exploratory Analysis

Because experience has been demonstrated to be a key factor in the use of configural processing, it is possible that those with more experience with infants may respond to this configural disruption differently. The above analysis was repeated, this time with the addition of parental status as a between subject factor (i.e., a 2 X 2 X 2 ANOVA). This analysis did not indicate any significant main effect of parental status, $F(1,117) = 1.01$, $p = .316$, $\eta^2G = .006$, or interaction between parental status and any of the other factors, all $F < 0.77$, all $p > .382$, all $\eta^2G < .001$. However, it is important to note the exploratory nature of this analysis. The sample only included 9 parents, so the group sizes differ dramatically making it difficult to interpret these results.

Discussion

The current study examined the impact of configural disruptions for adults and infant faces using the Thatcher Effect (TE). Previous research has consistently demonstrated a reliance on configural processing strategies for face perception (Carey & Diamond, 1994; Farah et al., 1998; Mondloch et al., 2002), however this work has been done exclusively with adult face stimuli. Given the difference in affective responses to infants compared to adults, it is possible that the processing of these two face categories differs at the perceptual level. The current study used TE, a well-established configural manipulation, to determine whether configural processing is used to the same degree for infant faces as it is for adult faces.

The significant main effect of orientation highlighted that the TE scores were significantly larger for faces in the upright condition compared to the inverted condition, regardless of face category. The results align with the a priori hypothesis that there would be a significant main effect of orientation in which the TE scores would be larger when faces were upright. Previous studies have consistently observed that the TE is an orientation-dependent effect, with Thatcherization having a much more noticeable impact on faces when viewed in the upright orientation than when inverted (Bartlett & Searcy, 1993; Carbon & Leder, 2005; Hoehl & Peykarjou, 2012; Maurer et al., 2002; Murray et al., 2000; Rhodes, 1988). The current findings are in line with this observation. This significant finding serves as a “manipulation check” ensuring that Thatcherization does impact the faces used in the current study as would be expected.

There was a trend for the effect of face category whereby TE scores were somewhat lower for infant faces than adult faces, although it failed to reach statistical significance and had a relatively low effect size. I did not have a specific a priori hypothesis regarding the main effect of face type given that so little is known about the perceptual processing of infant faces. The existing relevant literature provides equivocal findings regarding the use of configural processing for infant faces.

Most people will have more exposure and experience with faces of their own-race, relying heavily on configural processing for own-race faces. Expertise in facial processing and recognition gives humans the ability to adapt to their environments. Because we have more experience with faces of our own-race, we see the ORE in adult faces. Studies that investigated the ORE in infant faces had different outcomes. Several studies that found the ORE for infant faces suggested that we use configural processing just like we do for adult faces (Levin, 2000; Ng & Lindsay, 1994; Sangrigoli & de Schonen, 2004b). However, a number of studies that did not find the ORE in infant faces suggest that perhaps we do not use as much configural processing for infant faces as adult faces (Kelly et al., 2007; Sangrigoli et al, 2005). Or that infant faces may not be susceptible to configural disruptions, perhaps because most people have more experience with adults than infants.

Although it is not possible to draw any definitive conclusions based on the current, non-significant finding, it does suggest that the overall use of configural processing strategies may differ when viewing adult versus infant faces. Future work on this topic should employ a variety of face perception techniques (e.g., attentional paradigms, memory paradigms) to further explore this issue. Importantly, the results supported the predicted interaction between face type and orientation. Here, I show that configural disruptions impact the processing of adult faces to a greater degree than infant faces when viewed in a typical fashion (i.e., upright). This finding suggests that we rely more heavily on configural processing strategies for adult faces than for infant faces (Farah et al., 1998; Tanaka & Farah, 1993; Tanaka & Sengco, 1997), potentially due to people having more exposure and experience with adult faces. A way to explore this exposure hypothesis further would be to repeat the study using parents or people with lots of experience with infants (e.g., childcare, schools, healthcare, etc.) to see if those experiences with infants leads to a greater disruption with Thatcherization.

Limitations & Future Directions

There were several potential limitations of the current work. Due to COVID-19, all data collection occurred online with no oversight from the researchers, allowing some participants to potentially be distracted (e.g., one participant had over 6,000 second study time while the average was only 1,100 seconds). However, it is important to note that many pre-COVID studies used online data collection and it is a widely-used practice in research. Importantly, previous research on people's responses to faces has indicated that face recognition performance is very similar when data is collected online versus in the lab (Metzger et al., 2003), so it is unlikely that this significantly impacted the findings reported here.

Additionally, this study employed a relatively large number of stimuli (240 trials in total), which could potentially cause participants to get bored and lose interest, thus, becoming distracted or contribute to visual fatigue. The adult and infant faces were presented in separate blocks and these blocks were counterbalanced across participants so any fatigue effects should have equally impacted the adult and infant face stimuli and are thus unlikely to have any systematic impact.

Another potential issue lies in the difference in quality between the adult and infant facial stimuli. The inherent differences in standardizations of stimuli for adult faces (taken in a research setting) versus infant faces (collected from various online sources) could potentially impact participant responses to the faces generally. However, every effort was made to standardize the infant faces as best as possible (i.e., only faces that appeared head-on with good lighting quality were selected). Also, given that the TE scores were calculated within face this should not have any effect on the impact of the Thatcherization measure here.

The face stimuli were all of white, European-American adult and infant faces, but the participants were diverse in ethnicity (see Table 1). There is a well-documented ORE that influences configural processing so viewing faces from different ethnicities could have influenced the results. Participants viewing faces *not* of their own ethnicity would likely already be utilizing less configural processing and therefore be less susceptible to the Thatcher Effect. The sample here was over half white (54%) and repeating the reported analysis on only this subset of participants produced a similar pattern of results. I decided to report my main analysis on the full dataset because psychology research has historically lacked diversity in the populations sampled. Future work on this topic could explore the potential impact of participant and/or face ethnicity on the use of configural processing for infant faces in particular.

Finally, we were not able to fully explore the potential impact of expertise on face processing in the current study. Regarding the role of expertise, participants were asked whether they were a parent, presumably because parents have more expertise with infant faces compared to non-parents. The exploratory analysis including parental status did not indicate that this presumed additional experience with infant faces impacted configural processing in any observable way. However, the sample of parents was very small (N = 9) so it is difficult to draw any meaningful conclusions from this analysis and it should be treated as speculation. Future research could seek to compare parents versus non-parents using a properly balanced sample.

An additional limitation regarding experience is that this study did not take into consideration other aspects of experience with or exposure to infants. Without these additional experience-related questions, I was unable to capture non-parental family members or people who worked with children (e.g., childcare, education/schools, healthcare, etc.). This would be an interesting avenue for future studies to explore to further tease out the role of expertise in the use of configural processing for infant faces specifically.

Conclusion & Implications

Previous research suggests that infant faces are processed differently than adult faces, particularly in that infant faces may not be susceptible to the ORE, suggesting that we may not rely as heavily on configural processing for infant faces. The current study supports this claim by demonstrating that infant faces are less susceptible to the Thatcher Effect, a well-documented configural disruption, than adult faces.

Given that configural processing is important for memory and recognition of faces (Cabeza & Kato, 2000; Maurer et al., 2002), the results presented here suggest that adults may be less capable of remembering or individuating infant (and possibly child) faces as compared to adult faces. This may be particularly important for anyone working with children (e.g., teachers, administrators, social services, etc.). The role of experience or expertise in developing greater configural processing would be particularly important to understand here.

Face-to-face interactions have been shown to be especially important for infant development, particularly with their caregivers (see Parsons et al., 2010 for review). In light of this, a better understanding of how adults process infant facial cues has important implications for parental behavior and caregiver-infant bond formation. Previous research in a medical/clinical setting has even shown that infants in the NICU may be subject to different levels of medical care as a result of their facial appearance (Badr & Abdallah, 2001). Although adults seem to be particularly attuned to infants (e.g., infant faces attract visual attention, Hodsoll et al., 2010; infant faces elicit specific patterns of neural activation, Kringelbach et al., 2008), the current study suggests they may not be processing infants faces in as much depth as they do adult faces or at least that there are fundamental differences in the early perceptual processing of infant faces.

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