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The Effects of Emotion on the Holistic Processing of Faces

Julianna M. Murray
Montclair State University

Abstract

Face perception is an important ability that allows us to carry out social interactions, recognize others, assess emotions, and understand social cues. Many researchers believe that faces are processed holistically, meaning that humans combine the many parts of a face into a single visual representation. The face is viewed as a complete whole, rather than a collection of specific facial features. Consequently, processing a face holistically makes it more difficult to selectively attend to parts of the face. A small subset of literature has showed that the emotional state of the perceiver can affect the degree to which a stimulus is processed holistically. However, most of this literature has used emotion induction to assess individuals' perception of neutral faces. Thus, not much is known about how emotional expressions in the face stimuli themselves affect holistic processing. The present study uses the Garner paradigm, a strong tool for measuring selective attention, and a classification task in order to assess the effects of negative, neutral, and positive facial expressions on the holistic processing of artificially constructed face stimuli, known as composite faces. Findings show some support that negative faces are not processed holistically, and that positive expressions facilitate greater holistic processing. Results also suggest that neutral faces do not promote holistic processing. The present study overall suggests that holistic perception is not an automatic process, as previously asserted, and that the emotional context of a face dictates the strength and presence of holistic processing.

MONTCLAIR STATE UNIVERSITY

The Effects of Emotion on the Holistic Processing of Faces

by

Julianna M. Murray

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Thesis Committee:

[redacted]

Dr. Yoav Arieh, Thesis Sponsor

[redacted]

Dr. Jennifer Pardo, Committee Member

[redacted]

Dr. John Paul Wilson, Committee Member

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JULIANNA M. MURRAY

Montclair State University

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The Effects of Emotion on the Holistic Processing of Faces

Faces are among the most important visual stimuli we encounter. Our perception of faces allows us to gather important information, identify others, assess emotions, and interact accordingly. Face perception is important for understanding and making inferences about social interactions, face recognition, race-relations, and social cues (Zhao, Hayward, Bulthoffa, 2014; Bruce & Young, 1986). The ability to identify face parts and process them accurately is an important aspect of face perception, and many researchers have explored the mechanisms that facilitate this process.

Holistic Processing

One important area of discussion within face perception research revolves around how faces are represented and processed. Models have suggested that humans represent faces as gestalt wholes by combining individual facial features into a single visual representation (Farah, Wilson, Drain, & Tanaka, 1998; Rossion, 2013; Peterson & Rhodes, 2006). This integration of facial information stands as the basis of support for what is known as holistic face processing. Humans tend to recognize and identify a face as a complete unit, rather than a pair of eyes, a nose, followed by a mouth.

This type of processing has been shown to play an important role in the first-order stage of perception, where the spatial configuration of a face is detected (Taubert, Apthorp, Aagten-Murphy, & Alais, 2011). A fair amount of literature has concluded that faces presented upside down encourage feature-based processing, and thus are not processed holistically (Rossion, 2013, Rossion & Gauthier, 2002; Richler, Mack, Palmeri, & Gauthier, 2011). The presence of feature-based, or analytically-focused, attention in these inverted faces helps demonstrate that holistic processing is important for face recognition and detection (Taubert et al., 2011; Maurer, Le Grand, & Mondloch, 2002). Inverted faces are also far less readily encoded and identified as being face objects, showing that holistic processing aids in processing speed (Taubert et al., 2011). Holistic processing has also been shown to be a significant part of healthy or normal functioning. Declines in holistic perception have been associated with types of autism and schizophrenia, as these individuals tend to naturally gravitate toward more feature-based perception (Palermo, Willis, Rivolta, McKone, Wilson, & Calder, 2011; Watson, 2013).

Despite being a valuable ability, with implications for face recognition, detection, and discrimination, holistic processing does have an important consequence. Processing a face as a complete unit means it is difficult to selectively attend to specific parts of the face. Support that illustrates this consequence largely stems from research showing how a single feature or part of the face influences how one perceives the entire face (Rossion, 2013). Altering one aspect of the face impacts the perception of the whole face. Likewise, much of literature on holistic processing involves studies that show how difficult it is to focus on, or selectively attend to, a single part of the face (Young, Hellaway, & Hay, 1987; Gasper & Clore, 2012; Rossion & Retter, 2015; Fitousi, 2015; Farah et al., 1998). Many of these studies involve matching tasks, in which participants make judgements about two faces. In one such study, which asked participants to decide if two consecutively presented faces had the same target facial feature, (e.g. eyes), more errors were made when irrelevant facial features (e.g. mouth, nose) also differed (Farah et al. 1998). Selectively attending to only the eyes, for example, is affected by differences between or changes in the mouths of the two faces. Thus, the participants’ performance indicates that it is difficult to focus only on a specific part of the face, suggesting that we process faces in a holistic manner. One way researchers visualize this tradeoff in selective attention is through paradigms, such as the composite face paradigm, that assess attentional focus.

The Composite Face Paradigm

Further support for holistic face processing involves the composite face paradigm, which illustrates how the alteration of facial features can influence the perception of other face parts. This widely-used paradigm consists of the Composite Face Effect (CFE) and its task (Rossion, 2013; Richler, Floyd, & Gauthier, 2015). A composite face, which consists of a top and bottom half from two different faces, is used in these studies in order to evaluate holistic processing. Although artificially constructed, composite faces appear to be true, novel faces (see Figure 1). Composite faces are widely used in this area of study, as they allow researchers to alter the identity, positioning, and composition of faces during tasks.

Figure 1. A Composite Face.

The CFE occurs when two composite faces are compared to one another during a matching or same-different task. In this task, the viewer is told to focus only on the top halves of two sequentially-presented faces, and indicate if the top halves are the same or different. When viewing two composite faces that have the same top halves, but different bottom halves, one will tend to perceive the top halves as also being different, even though they are identical. Even when viewing these faces side by side, individuals will still perceive the top halves as being different from one another, solely due to the differing bottoms halves (see Figure 2). Thus, the bottom half of the face influences, or interferes with, the perception of the top half. This inability to ignore the bottom half of the face provides support for holistic perception, showing the tendency to view faces as a complete whole. Poorer performance on the CFE task, as measured by slow reaction time and poor accuracy, indicates that participants were not able to correctly selectively attend to or distinguish between the top halves. Better performance on the CFE task indicates that the irrelevant half of the face did not interfere with one's ability to focus on the target face half.

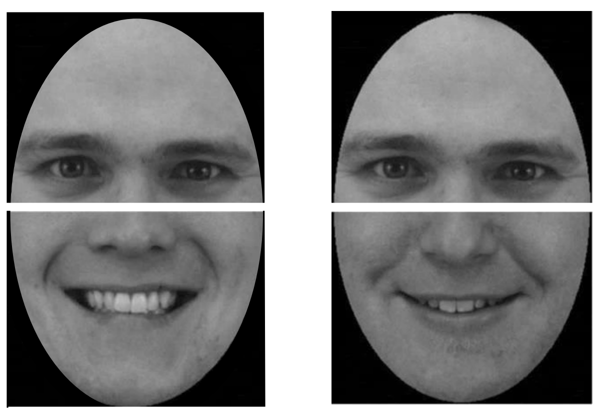


Figure 2. An Example of the Composite Face Effect. The top halves are identical to one another, but they appear to be different solely due to the differing bottom halves. Thus, the bottom halves interfere with and affect the perception of the top halves.

Earlier research has showed support for this effect in familiar faces. In a study by Young and colleagues (1987), top and bottom halves from different popular celebrities' faces were combined to form unfamiliar composite faces. Despite being familiar with the individual face halves themselves, people had trouble recognizing and identifying which celebrity a particular face belonged to when it was paired with an unmatched face half (Young et al., 1987). This demonstrated that it was difficult for people to ignore the irrelevant half of the faces, as they instead processed the entire face. Hole (1994) later showed that the composite face effect can be seen in novel composite faces that were constructed from images of unfamiliar faces. In trials where the top halves of the composite faces were identical, but bottom halves differed, individuals found it difficult to correctly identify the top halves as being the same (Hole, 1994). This also demonstrated that people were unable to ignore the irrelevant half of unfamiliar faces, showing that novel faces are too processed holistically.

Previous literature has also assessed spatial alignment in faces, and found that misaligned faces are not processed holistically. Hole (1994) has showed that the CFE is not present when the top and bottom face halves are misaligned or horizontally offset from one another: When a composite face is misaligned, it is much easier to process the face halves independently (see Figure 3). Viewers are more likely to perceive a misaligned face more locally or analytically, effectively focusing on a specific face part or half. Thus, in misaligned trials, people tend to be much faster and more accurate in identifying face halves as ‘same’ or ‘different’, in comparison to aligned faces (Rossion, 2013).

Moreover, in seeing if different parts of the face would be processed independently from one another, Fitousi (2015) asked participants to identify and match face halves. Participants were familiarized with four composite faces, which were either aligned or misaligned, depending on the trial. They were then presented with one of these faces, and were asked to classify whether or not the top or bottom half of the target face

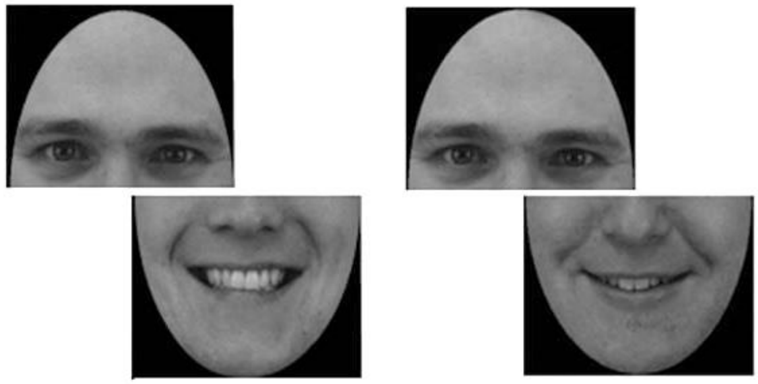


Figure 3. Misaligned Composite Faces in the Composite Face Effect. Misaligning the face halves makes it much easier for viewers to see that the top halves are indeed the same, illustrating that misaligned faces are not processed holistically.

was the same as the one in the familiarization trial. Fitousi (2015) did find support for the CFE, as reaction times were overall slower in aligned trials in comparison to misaligned trials: It was more difficult for participants to attend only to the top half of the faces when they were properly aligned. Horizontal shifts in alignment between face parts make it easier for people to selectively attend to one part of the face, thereby decreasing holistic processing.

There has also been interest in how the construction of the composite face may influence holistic processing. Some studies have shown that the presence of a slim gap in between the top and bottom halves of a composite face increases holistic processing. Rossion & Retter (2015) asked participants to identify which of two faces, presented simultaneously, is the composite face, and which is a true face. When both of the faces did not have a gap between the halves, participants were almost always able to identify the composite face (Rossion & Retter, 2015). It may be assumed that the participants were better able to see that the halves of composite faces were not seamlessly integrated in the way that true face halves were. However, when a gap was present between the top and bottom halves, the participants were unable to tell which stimulus was a true face, and which one was a composite face (Rossion & Retter, 2015). Thus, with the gap, composite faces looked just as likely to be real faces as the true faces did. The gap in the composite face likely provides the separation necessary to remove the contrast created from stitching a bottom and top half from two different faces together. This gap also seems to be necessary for participants to accurately define the top half of the composite face, which is essential in assessing holistic processing in the CFE task (Rossion & Retter, 2015). Therefore, the presence of a gap in a composite face is important for creating the composite face effect and evaluating holistic processing.

Overall, a multitude of researchers have examined holistic processing solely through the composite face paradigm and the CFE, comparing performance between aligned and misaligned trials. However, some have pointed out that this design may not measure or assess a single definition of holistic processing (Richler, Palmeri, & Gauthier, 2012). The CFE not only measures selective attention, but also measures how alignment, or spatial positioning, influences processing. These two measurements may not represent the same constructs and mechanisms that underlie holistic processing (Richler et al., 2012). Therefore, utilizing the Garner paradigm, a strong tool for specifically measuring selective attention, is a better assessment of holistic processing.

The Garner Paradigm

The Garner paradigm is a tool that is used to examine one’s ability to selectively attend to different aspects, or dimensions, of a stimulus. This paradigm measures how much interference is present during a task by comparing baseline and filtering conditions to one another. In the baseline condition, the irrelevant dimension of the stimulus is kept constant between trials, while the target dimension varies randomly. The filtering condition incorporates a randomly changing irrelevant dimension that varies from trial to trial (Algom & Fitousi, 2016). Comparing performance between the baseline and filtering conditions reveals if the two dimensions are separable or integral. Separable dimensions are able to be processed independently of one another. Conversely, integral dimensions are processed together as one entity in the brain, and their components are more difficult to separate from one another. If the random changing of the irrelevant dimension in the filtering worsens performance relative to baseline, then the dimensions are said to be integral due to the interference present. However, if task performance is the same for both the baseline and filtering blocks, then the dimensions are understood to be separable.

In the context of holistic processing, if the task is to make judgements about the top halves of two composite faces, then the (irrelevant) bottom halves will remain the same, and the top halves will vary in the baseline condition. For example, in a matching task, a participant can be presented with two composite faces, where the top halves are either A or B, but the bottom half is always C. Here, the baseline trials would allow researchers to assess a participant's ability to attend only to the relevant top halves of the faces, without any interference from the bottom half. In the filtering condition, trials contain two composite faces, whose top halves can either be A or B, and whose bottom halves can either be C or D. Thus, both dimensions vary randomly between trials. The filtering condition assesses performance when the irrelevant face half is also changing. If the randomly varying bottom half affects a person's ability to identify the top half as A or

B, then Garner interference is present. By comparing a person’s performance in their baseline trials to that of their filtering trials, it is possible to see if the changes in the irrelevant dimension interfered with the perception of the target dimension. Worse performance in the filtering condition, as measured by higher reaction times and more incorrect responses, would indicate that the irrelevant dimension did interfere with selective attention. This interference in the filtering condition is indicative of holistic processing. Being unable to ignore the irrelevant bottom half shows that the viewer has trouble focusing on specific parts of the face, and rather tends to view the face in a more holistic manner.

Emotion

Moreover, some of the literature on perception studies indicates that the degree to which a stimulus is processed holistically may depend on the emotional state of the perceiver. Early research has supported a connection between the induction of negative emotions and part-based processing. One such study found that those who were exposed to a ‘negative game’ (as characterized by negative incentives through losing points) were more likely to process figures and shapes in a more local manner, as they tended to focus on individual parts of the figure (Derryberry & Reed, 1998). Additionally, using large letters that were made up of the same, but smaller letters in a hierarchical stimuli task, Gasper and Clore (2002) supported the notion that individuals induced with sadness tend to focus on the smaller letters, or the more local features of a stimuli. Other early research has found that positively-induced emotions led participants to adopt a more global scope of attentional focus during a visual processing task (Fredrickson & Branigan, 2005). People who were shown positive images, intended to induce happy or elated moods, were found to make judgments about visual stimuli using a more global or holistic type of attentional focus (Isbell, Burns, & Haar, 2005). Similar findings concluded that people who were high in positive affect and optimism tended to view visual stimuli more globally (Basso, Schefft, Ris, & Dember, 1996).

More recent studies have applied this local versus global literature to face perception, and have found consistent conclusions regarding the role of negative and positive affect in holistic processing. Specifically, Curby, Johnson, & Tyson (2012) induced positive and negative emotions in participants through films, and used the CFE task to assess if interference impacted their ability to correctly match top halves as same or different. Those in the negative emotion induction group showed better performance when the irrelevant half differed, indicating that participants were able to ignore the unrelated part of the face more easily (Curby et al., 2012). This shows support for a decline in holistic face processing in people who were induced with negative emotions. Additionally, Xie and Zhang (2016) found that participants induced with positive mood performed worse on the CFE task in comparison to those in the negative and neutral conditions, indicating that a positive emotional state facilitated greater holistic processing. They also found that negative emotion induction promoted less holistic processing in the CFE task (Xie & Zhang, 2016). Overall, the literature seems to associate negative affect of the perceiver with more feature-based processing, and positive affect with stronger holistic processing.

The Present Study

Despite the increasing interest in selective attention and face perception, there is still a lack of research that explores how emotional expression of the face stimuli themselves may affect holistic processing. Researchers have not widely used emotional faces in their studies, and often rely on emotion induction methods or tasks when assessing participants' perception of neutral faces. Also, past research has not explored the holistic face perception of emotional composite faces using a Garner paradigm to assess how judgments about target face parts are influenced by other face parts. With the human face being a very common visual stimuli, capable of conveying a range of emotions, it seems that the existing body of research is missing the importance of exploring how facial expressions affect selective attention and holistic processing. Therefore, it would be significant to assess holistic face perception using composite faces with emotional expressions, rather than incorporating emotional induction of the perceiver into the design. Such a study can provide a stronger understanding of how attention, nonverbal communication, and holistic processing connect.

The current study seeks to build upon past literature by exploring holistic face processing through the use of emotional composite face stimuli and the Garner paradigm. The paradigm here serves as the design for this study, as it is a very strong tool that focuses solely on selective attention. This study also incorporates a speeded classification task similar to that of Fitousi's (2015) study.

Additionally, the present study explores if the findings from the emotion induction and holistic processing literature can be extended to emotional composite faces. I hypothesized that participants will demonstrate decreased holistic processing when viewing composite faces with negative expressions. Therefore, performance in the baseline and filtering blocks in the negative condition is expected to be no different than one another, as similar performance in the baseline and filtering blocks indicates holistic processing and a lack of interference. It is also hypothesized that Garner interference will not only be found with the neutral faces, but also that positive faces will facilitate the strongest presence of holistic processing. Here, it is expected that reaction time and accuracy will be worse in the filtering condition, relative to baseline.

Methods

Participants

A total of 26 undergraduate students took part in this experiment. All participants were at least 18 years of age and were recruited through the Sona Systems subject pool website. Participants were compensated one credit toward their course assignment requirement upon taking part in the experiment. All participants completed the study successfully. Upon preliminary analyses, two participants were found to have an overall accuracy below 75% correct, a subjective cutoff, and were eliminated from further analyses, leaving 24 total participants for analyses. The study took place in a research lab on the Montclair State University campus, and informed consent was obtained following the IRB approved protocol.

Design

This study consisted of a 3×2 within-subjects design. Emotional condition and trial type were the two independent variables in this study. Emotional condition referred to the type of emotional expression present on the composite face stimuli, and had three levels: negative, neutral, and positive. Block type was the second independent variable, and had two levels: baseline and filtering. Each of the three emotional conditions contained both baseline and filtering blocks, forming 6 total conditions. Within each of these conditions, two dependent variables were measured: reaction time and error rate.

Reaction time measured how many milliseconds elapsed from the time the composite face was presented until a response key-press was initiated. Error rate was calculated from participants' key-presses, which were recorded for each trial as correct or incorrect. Each participant was exposed to all 6 conditions, resulting in within-subjects, repeated-measures study. The order in which participants received each of the three emotional conditions, as well as the baseline and filtering blocks within each condition, was counterbalanced.

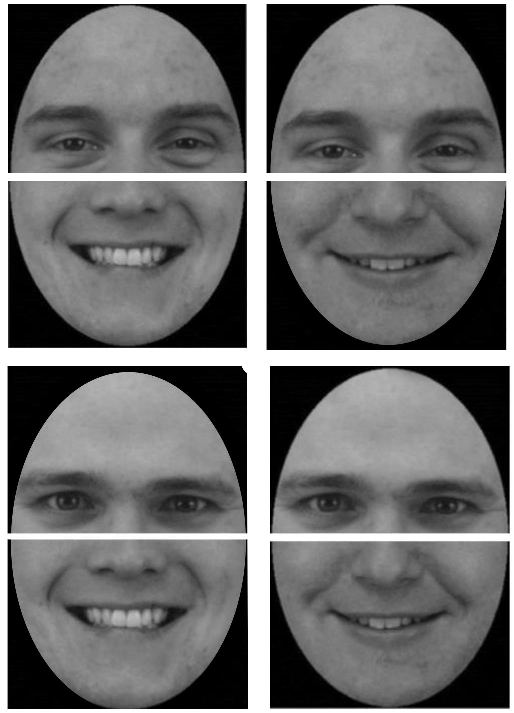
Materials

Face stimuli. The face stimuli used in this study were gathered from the Karolinska Directed Emotional Faces (KDEF) database (Lundqvist, Flykt, & Öhman, 1998). This is an open database containing thousands of images of faces with positive, neutral, and negative facial expressions (Goeleven, De Raedt, Leyman, & Verschuere, 2008). Positive expressions convey emotions such as happiness, surprise, and excitement, while negative expressions include anger, fear, and sadness. To create one of the three sets of composites, four different faces were chosen from this database. Two top halves (A and B) were chosen from two of these faces, while two bottom halves (C and D) were taken from the two remaining faces. Thus, four novel composite faces (AC, AD, BC, and BD) were formed. This process was completed for each of the three emotional face types, resulting in 12 composite faces. All composite faces were cropped into the same oval shape in order to produce a consistent face shape and size for the viewer. These composites were presented in grayscale, with a black background and a thin white line separating the top and bottom halves. See Figure 4 for one of the complete sets of composite faces.

A

Top Half

B



C D

Bottom Half

Figure 4. One Complete Set of Four Composite Faces. The faces used in the positive emotional condition are seen here. Two top halves (A and B) and two bottom halves (C and D) were combined in a full factorial to create four novel composite faces.

SuperLab. This classification task was created with and presented using the SuperLab software. This program allowed for the specification of blocks, conditions, trials, and length of each stimuli presentation. This program also made sure that the exposure of stimuli was consistent among participants. SuperLab randomized the trials within each block, as well as recorded reaction time and accuracy for each key-press executed by participants.

Procedure

Classification task. The overall goal of the participant's task was to correctly classify the top half of a given face as Top Half A or Top Half B. After an initial familiarization stage of the two top halves, participants viewed images of whole faces. Only one composite face per trial was presented. For each trial, an image of a face appeared in the center of the screen, and participants pressed either the A or B key, (located on the “A” and “L” keys on a standard QWERTY keyboard), to indicate which top half is present in the face. The participants’ task remained the same for all trials and blocks, as only the face stimuli changed between conditions. In one baseline block, the top halves in each trial varied randomly between A and B, while the bottom half remained C. The other baseline block held bottom half D constant. In the filtering trials, both top halves A and B, as well as the bottom halves C and D varied randomly between one another. In a single trial, a participant sees a focus point followed by a single composite face. There were 80 baseline trials and 80 filtering trials in each of the three emotional conditions, resulting in 480 total trials in this study. Participants completed this task three times, one for each emotional condition. See Figure 5 for the structure of a single trial in this task.

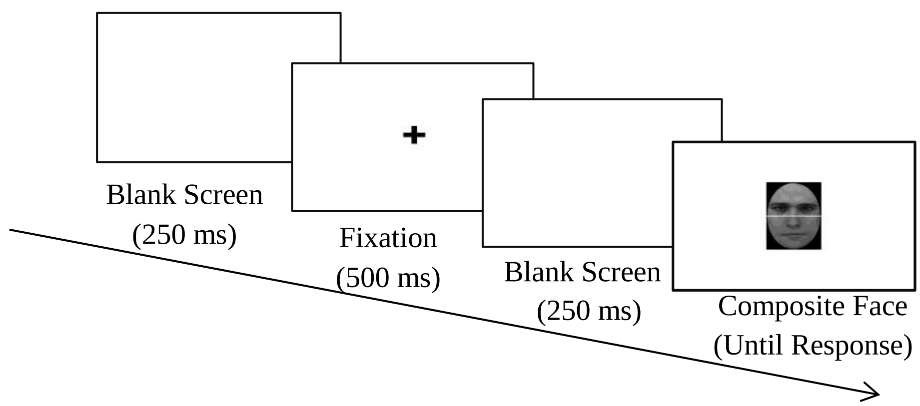


Figure 5. Timeline of a Trial in the Classification Task. After a focus point, participants see a single composite face and indicate, through a key press, if Top Half A or Top Half B is present.

General procedure. Participants were seated in a quiet, noise-controlled sound booth that housed the computer and monitor. An instruction screen described the classification task and its objective. Participants were also instructed to only focus on the top half of the face, while ignoring the bottom half, and to respond as quickly as they can, without sacrificing accuracy. Participants next completed the familiarization stage. In this stage, Top Half A and Top Half B were labelled “A” and “B”, respectively, and were presented one by one. Individuals pressed "A" and "B" on the keyboard accordingly as the top halves appeared. Twenty trials of each top half were presented randomly, followed by 20 unlabeled halves. A much shorter version of this familiarization stage was repeated in between the baseline and filtering blocks. Participants then completed 10 practice trials of the classification task, in which whole faces were presented. After the practice block, the participants began the main classification task described above. This procedure was repeated for all three emotional conditions, such that participants completed three total sets of familiarization, practice, and experimental stages.

Analyses

Between-conditions analysis. The median reaction time and error rate for the baseline and filtering blocks for each emotion condition were computed for every participant. Median values were obtained due to the presence of outliers in the data. Mean reaction time and error rate were then aggregated for each condition. These numbers were fed into general linear model repeated-measures ANOVAs in order to compare reaction time and accuracy between the baseline and filtering blocks for each emotional condition. Finally, paired-sample t-tests were conducted to obtain the magnitude of difference between baseline and filtering blocks

Within-condition analysis. Each trial a participant views may be influenced by the trial preceding it. As such, it is important to assess performance differences at the trial-by-trial level within the filtering condition. Therefore, in order to obtain a more sensitive and stronger analysis, a Within-condition analysis was conducted. Because the irrelevant dimension (i.e. bottom half) varies randomly between C and D in the filtering conditions, it is possible to have mini baseline and filtering trials within a single filtering block, depending on which trial precedes the next. If a trial presents a face with the same bottom half as the trial preceding it, then it can be considered a mini-baseline trial. Likewise, if the trial shows a bottom half that differs from the one before it, it is labeled as a mini-filtering trial. Thus, for this Within-condition analysis, every trial (except for the first) in each filtering block was coded as either mini-baseline or mini-filtering (see Figure 6 for a visual representation of how these mini-baseline and mini-filtering trials were created). This produced a new set of baseline and filtering trials for each emotion condition with which to conduct repeated-measures ANOVAs and t-tests.

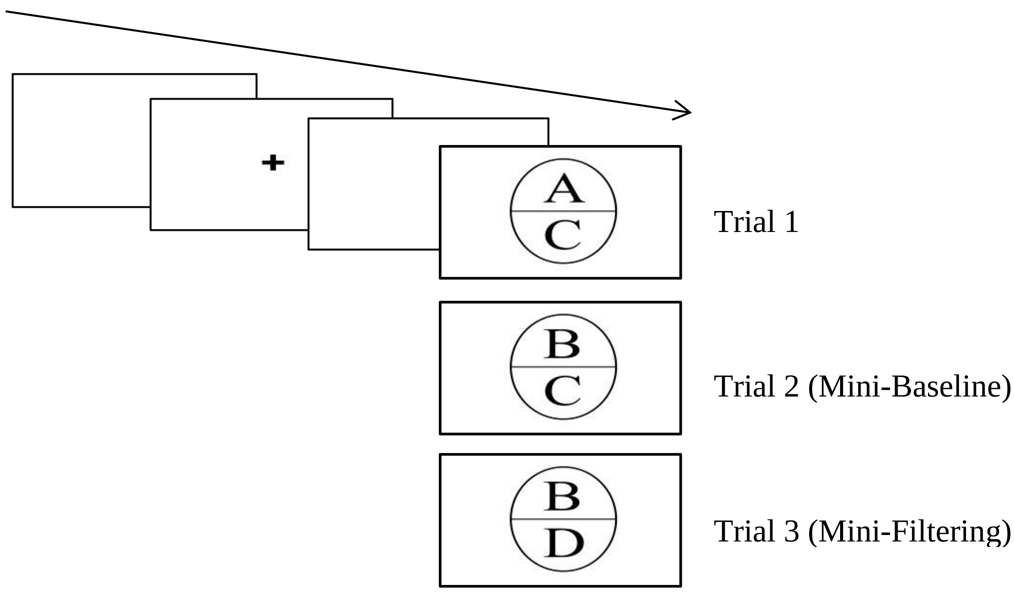


Figure 6. Forming the Within-Condition Mini Baseline and Filtering Trials. For every filtering block, each trial was labeled as mini-baseline or mini-filtering depending on the trial that preceded it. For example, Trial 2 here is labeled as mini-baseline because it contains the same bottom half (C) as Trial 1. The irrelevant half did not change among trials. However, Trial 3 is labeled as a mini-filtering trial because its bottom half (D) differs from that of the trial preceding it (C).

Results

Between-Conditions Analysis

Reaction time. A 3×2 repeated measures ANOVA showed that the main effects for emotional condition, $F(1, 23) = .304$, $p = .74$, $\eta_p^2 = .027$, as well as for block type, $F(2, 22) = .417$, $p = .53$, $\eta_p^2 = .018$, were not significant. The interaction between these variables was also not significant, $F(2, 22) = .590$, $p = .56$, $\eta_p^2 = .051$. Regarding the negative emotional condition, a paired samples t-test showed that the difference in reaction time (milliseconds) between baseline (*M* = 615, *SD* = 84) and filtering (*M* = 616, *SD* = 54) blocks was not significant, *t*(23) = -.05, *p* = .96. In the neutral condition, baseline (*M* = 631, *SD* = 83) and filtering (*M* = 628, *SD* = 102) reaction times were also not significantly different from one another, *t*(23) = .27, *p* = .40. Notably, the biggest difference (18 ms) was found in the positive condition, although reactions times did not reach significance between baseline (*M* = 613, *SD* = 65) and filtering (*M* = 631, *SD* = 89) blocks, t(23) = -1.26, *p* = .11. See Figure 7 for mean reaction times for each condition.

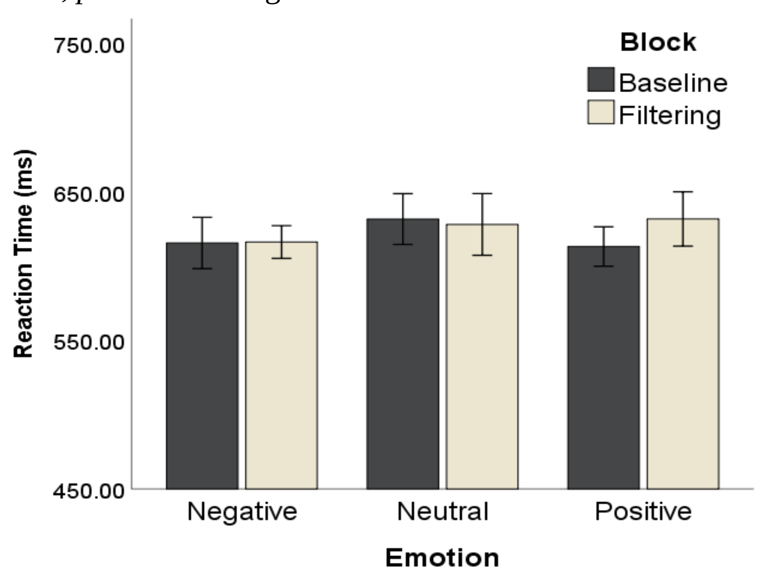


Figure 7. Between-Conditions Analysis: Mean Reaction Time for Each Condition. Error bars represent 1 standard error of the mean.

Error rate. A repeated measures ANOVA for error rate revealed that the main effects for emotion, $F(2, 22) = 1.35$, $p = .28$, $\eta_p^2 = .107$, and block type, $F(1, 23) = .26$, $p = .62$, $\eta_p^2 = .011$, were not significant. The interaction was also not significant, $F(2, 22) = 1.07$, $p = .36$, $\eta_p^2 = .088$. Paired samples t-test showed that mean error rate (%) did not differ between baseline (*M* = 8.44, *SD* = 12.42) and filtering (*M* = 6.82, *SD* = 7.94) blocks in the negative condition, $t(23) = -.866$, p = .40. Likewise, neutral faces did not prompt significant differences in error rate between baseline (*M* = 8.91, *SD* = 16.14) and filtering (*M* = 5.10, *SD* = 4.90) blocks, $t(23) = -1.17$, p = .13. Only in the positive emotion condition were error rates lower for baseline than filtering (*M* = 9.01, *SD* = 12.55) and (*M* = 11.67, *SD* = 20.66), respectively, but the difference was again not significant, $t(23) = .69$, $p = .25$. See Figure 8 for mean error rates across conditions.

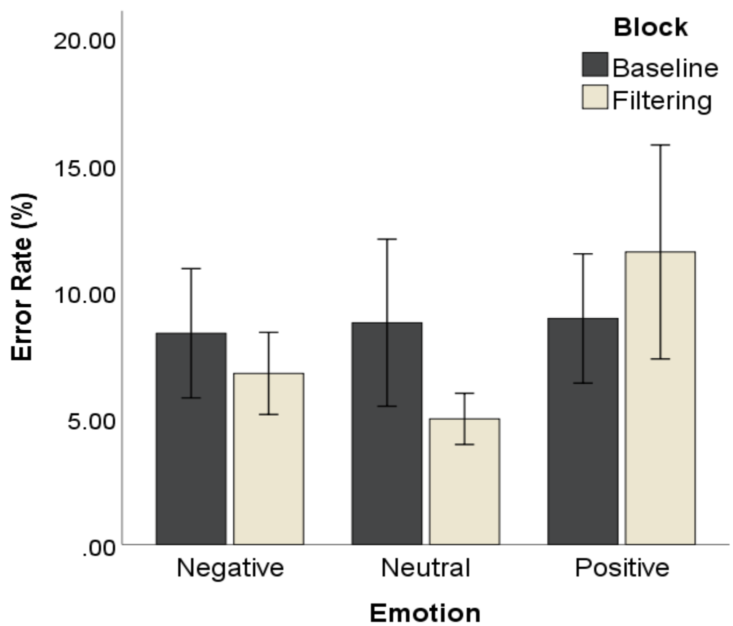


Figure 8. Between-Conditions Analysis: Mean Error Rate for Each Condition. Error bars represent 1 standard error of the mean.

Within-Condition Analysis

Reaction time. Regarding reaction time, there were no main effects found for emotion, $F(2, 22) = .71$, $p = .16$, $\eta_p^2 = .061$, or block type, $F(1, 23) = .95$, $p = .34$, $\eta_p^2 = .039$. However, a significant interaction was found, F(2, 22) = 5.01, p = .016, $\eta_p^2 = .313$, which means that the difference between baseline and filtering varied in magnitude and direction depending on the emotional condition. Indeed, reaction times in the negative condition for baseline (M = 673, *SD* = 98) and filtering (*M* = 690, SD = 98) did not differ significantly from one another, $t(23) = -1.02$, $p = .32$, and this difference for neutral baseline (*M* = 695, *SD* = 132) and filtering (*M* = 676, *SD* = 130) only approached significance, $t(23) = 1.70$, $p = .054$. However, the difference in the positive condition between baseline (*M* = 647, *SD* = 98) and filtering (*M* = 676, *SD* = 131) was significant, $t(23) = -2.19$, $p = .016$. Reaction times were significantly higher for the filtering block in this condition. Additionally, only in the neutral condition was reaction time higher for the baseline block. See Figure 9 for the average reaction times from the within-condition analysis for each condition.

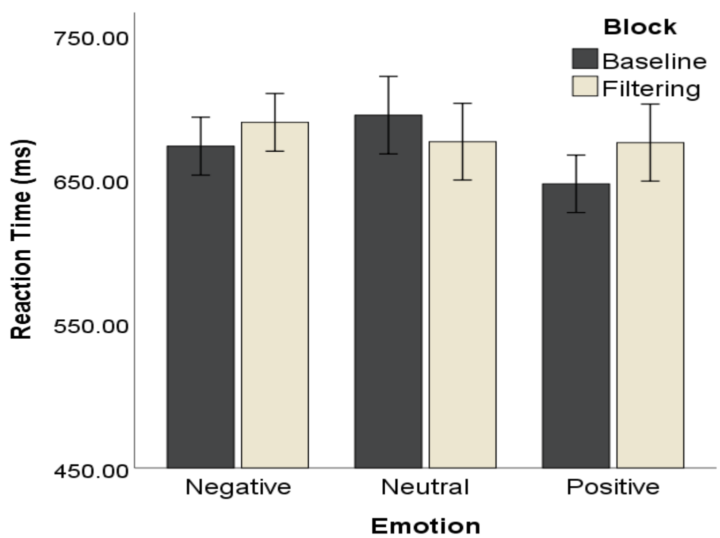


Figure 9. Within-Condition Analysis: Mean Reaction Time for Each Condition. Error bars represent 1 standard error of the mean.

Error rate. In terms of error rate, neither the main effect of emotion, $F(2, 22) = 1.80$, $p = .189$, $\eta_p^2 = .140$, nor trial type, $F(1, 23) = 1.00$, $p = .33$, $\eta_p^2 = .082$, were found to be significant. The interaction was also insignificant, F (2, 22) = 1.18, $p = .33$, $\eta_p^2 = .097$. Error rates for negative baseline ($M = 8.35$, $SD = 10.71$) and filtering ($M = 5.78$, $SD = 7.38$) blocks did not differ significantly from one another, $t(23) = -1.73$, $p = .10$. Similar results were found for neutral faces, as baseline ($M = 5.45$, $SD = 6.25$) did not differ from filtering ($M = 4.93$, $SD = 5.20$), $t(23) = -.55$, $p = .29$. In the positive condition, baseline ($M = 11.68$, $SD = 21.18$) and filtering ($M = 11.62$, $SD = 20.79$) blocks were not significantly different, $t(23) = -.07$, $p = .47$. However, the positive baseline and filtering blocks did show the highest error rates among the three emotional conditions despite the absence of significant main effects. See Figure 10 for mean error rates for each condition.

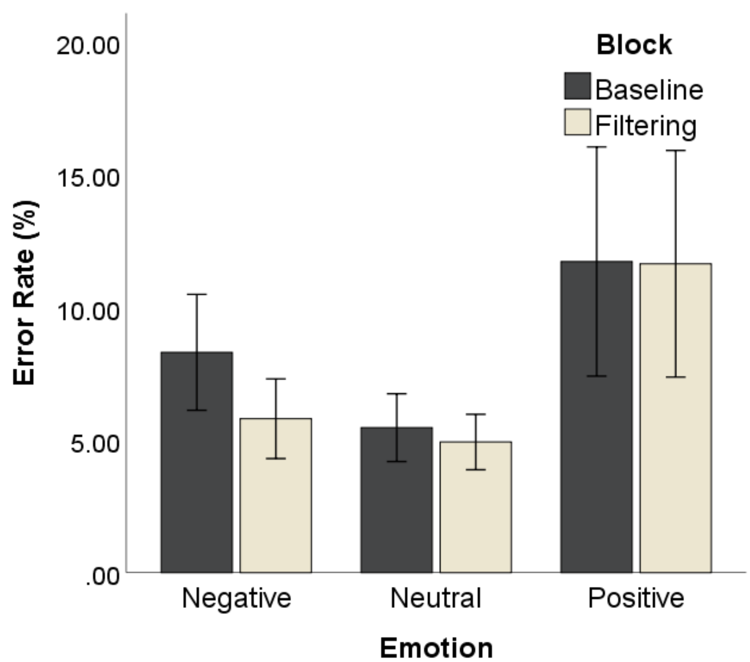


Figure 10. Within-Condition Analysis: Mean Error Rate for Each Condition. Error bars represent 1 standard error of the mean.

Discussion

The aim of the present study was to explore how emotion interacts with the holistic processing of faces. The Garner paradigm was utilized to examine how changes in the irrelevant dimension of a face influenced participants' perceptions of the target face half. The presence of Garner interference from the bottom half would serve as an indication that a face is processed holistically. The first hypothesis predicted that negative expressions would prompt less interference and holistic processing in comparison to neutral and positive faces, as demonstrated by an indifference in performance between baseline and filtering conditions. Overall, there were indeed no significant differences between baseline and filtering blocks in the negative condition, which indicates some support that negative faces facilitate less holistic processing. However, among these insignificant results, reaction time and error rate results were not consistent in showing the hypothesized lack of holistic processing. In both analyses, lower error rates in the filtering block indicated that the randomly changing bottom half was not costly, indeed suggesting a lack of holistic processing. However, the Within-condition analysis for reaction time showed a trend of worse reaction time in the filtering condition, suggesting a presence of interference and holistic processing. This Within-condition analysis alone indicated that participants were more accurate, but took longer to respond when the trial preceding the present one had a different bottom half.

The second hypothesis predicted that Garner interference would be observed in the neutral condition, and more so in the positive condition. This was partially supported, as only the positive condition showed indications of holistic processing: The irrelevant bottom halves tended to interfere with performance. The higher reaction times and error rates in the filtering blocks show that it was difficult to focus solely on the top half. The Within-condition analysis results were not only consistent with that of the Between-conditions, but also yielded a significant difference in reaction times for this condition. This showed that the Within-condition analysis was indeed more sensitive. On the other hand, the neutral composite faces seemed to prompt the opposite trend in performance. Garner interference was not found in this neutral condition, as performance tended to be better in the filtering block. Although non-significant, both analyses revealed that participants responded more quickly and accurately in the filtering trials in comparison to baseline when viewing neutral faces.

There are trends in these results that are consistent with previous literature. A fair amount of studies exploring holistic perception of visual objects and emotion have shown some support that negative emotions facilitate more feature-based processing (Curby et al., 2012; Xie & Zhang, 2016; Derryberry & Reed, 1998; Casper & Glore, 2002; Basso et al., 1996). Additionally, findings regarding the positive composites are consistent with other studies: Positive mood and expressions have been associated with a bias toward stronger holistic processing (Kaufmann & Schweinberger, 2004; Xie & Zhang, 2016). This has been supported in studies using positive emotional induction tasks as well as emotional health and state (Andreasen & Powers, 1975; Huntsinger, 2012; Isbell et al., 2005). The present results do have some correspondence with these trends in the literature.

However, the patterns in performance for the neutral emotional condition are surprising, and suggest that neutral faces prompt feature-based processing. This is a particularly interesting result because neutral faces have been widely used in studies examining face perception and holistic processing (for a review, see: Rossion, 2013). Nonetheless, the present results do add to the small subset of literature that does not fully support holistic effects. Fitousi (2015) found similar results in his first experiment, as Garner interference was not found with his composite faces, and ultimately concluded that composite faces are not processed in a holistic manner. Similar conclusions have also surfaced from studies utilizing other paradigms and tasks (Richler et al., 2012; Bradshaw & Wallace, 1971; Gold, Mundy, & Tjan, 2012). Although not all of these studies utilized neutral composite faces, the present results do add to the subset of literature that has challenged holistic processing.

Going further, one strength of the present study is that it utilized a within-subjects design, which improved upon past research that made conclusions based on a between-subjects design (Derryberry & Reed, 1998). Some researchers have also pointed out that there are individuals differences in performance for holistic processing and the CFE that may strongly interfere with the presence of these effects (Fitousi, 2015; Wang, Li, Fang, Tian, & Liu, 2012; Avidan, Tanzer, & Behrmann, 2011). Therefore, the within-subjects design here likely limited the error variance introduced through individual differences. Additionally, the Garner paradigm was used in this study to measure selective attention in the classification task. This is a strength because this paradigm measures a single definition of holistic processing unlike the composite face paradigm, which heavily emphasizes spatial alignment. As previously mentioned, the Garner paradigm is a strong tool that measures a single construct of holistic processing, making it a better tool for assessing selective attention.

However, there are limitations in this study that should be addressed. Firstly, the sample size (N = 24) most likely limited the power of this study. A power analysis conducted using the G*Power program sheds light on this matter (Faul, Erdfelder, Buchner, & Lang, 2009). This analysis revealed that the statistical power was .15 for detecting a small effect (d = .20; see Cohen, 1988), .65 for detecting a moderate effect (d = .50), and .96 for detecting large effects, suggesting that this study had inadequate power to detect small and moderate significant differences. Moreover, the face stimuli used may have limited generalizability. Even though the faces were completely novel, it may have been advantageous to have more than one set of faces for each emotional expression. It would be bold to conclude or suggest that neutral composites are not processed holistically, in which case, having participants complete the classification task with more than one set of faces per emotion may have yielded more reliable results. Another potential limitation lies within the design of this study. A classification task, rather than a matching task, was used in order to incorporate the Garner paradigm into the design. This required a familiarization block before the main task. Researchers have found support indicating that faces with positive expressions were rated as being more familiar than faces with other expressions (Kaufmann & Schweinberger, 2004). Others found that recognizing and making judgments about familiar faces rely more on global information (Lobmaier & Mast, 2007). If faces with positive expressions appear to be more familiar than those with other expressions, and if degree of familiarity is positively associated with holistic processing, then perhaps the familiarization blocks introduced bias into the results. Meaning, it may be possible that positive expressions led to more holistic processing in the present study because they were perceived to be more familiar after the initial familiarization stage. Using a task that does not require familiarization may have limited potential confounds set by any familiarity effects or biases.

Despite these limitations, there are implications of this research. This study shows that holistic processing is not automatic, but rather is influenced by the emotional context of the face. This challenges the existing literature that views holistic perception as a more automatic or reflexive process. This study shows that different emotional expressions on a composite face can impact the degree of holistic processing present. This suggests that it is important for researchers to be aware of the emotional composition of their face stimuli. Additionally, holistic processing is widely known as an underlying mechanism of face recognition. Therefore, emotional expressions may create variations in holistic processing, which in turn impacts important abilities such as face recognition. Also, this study shows that the Garner paradigm can be used to assess holistic processing in face stimuli. Scant literature has utilized this paradigm due to the heavy focus on the composite face paradigm, but these results imply that Garner interference can properly measure holistic processing. This study demonstrates that the Garner paradigm can produce results similar to studies that used other designs to assess face perception, and thus may encourage other researchers to incorporate this paradigm into their research.

Lastly, future studies should include more than one set of composite faces for each emotional condition. In this set up, it would be interesting to see if task performance is consistent across different sets of faces with the same expressions. Another future direction may involve executing this classification task with the addition of familiar faces. If positive expressions do indeed facilitate a stronger sense of familiarity, and thus stronger holistic processing, then familiar positive faces should facilitate more holistic processing than positive unfamiliar faces. Therefore, future research could assess how emotional expression and familiarity influence holistic processing. Additionally, other work could aim to include demographic information of the participants as a main variable. Although within-subjects designs limit error caused by individual differences, making some connections between holistic processing and demographic characteristics (e.g. gender, ethnicity, etc.) can lead to new inferences about other factors may influence holistic processing.

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