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Heart Rate and

Face Inversion Effect

Bachelor of Science Psychology

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Abstract

The face inversion effect is one of the most studied phenomena in facial recognition. The purpose of this thesis was is to determine if heart rate measures of attention and cognition might provide an explanation for the inverted face effect. Participants received a face memory task and heart rate was measured throughout the experiment. It was hypothesized that heart rate would change the most when processing inverted faces compared to upright, because of the increased task difficulty. Each participant experienced one of four conditions differing on face orientation presented during the learning phase (either upright or inverted) and face orientation presented in the testing phase (either upright or inverted). Also during the testing phase, participants received some familiar faces (old) from the learning phase as well as some novel (new) faces they had not seen before. No significant differences were found in heart rate for learning orientation, or while viewing upright faces or inverted faces when compared to baseline heart rate. The combined comparisons revealed that the combination of upright and inverted, and old and new faces all appeared to be experienced similarly. No interaction of learning phase orientation, testing phase orientation, and old vs. new during testing phase approached any significance. A significant interaction was found for learning and testing orientation. Future research should consider the limitations of this study and use a larger, more diverse sample. More research is needed to discern the physiological impact from the face inversion effect.

Heart Rate and Face Inversion Effect

The face inversion effect is one of the most studied phenomena in facial recognition. This topic is interesting because people are excellent face processors but the ability is orientation sensitive and is lost when a face is inverted or turned upside-down. Humans have a ton of experience with faces in a particular context (e.g., upright), however when the context changes (e.g., inverted) the ability essentially diminishes; this could have implications for all kinds of learning. In the current research the face inversion effect refers to the loss of ability to recognize faces when they are inverted. Upright faces are much easier to recognize than inverted faces because we have the ability to recognize upright faces as a quickly processing unit whereas inverted faces are processed as a set of parts (eyes, nose, mouth, etc.). According to Schwaninger, Ryf, and Hofer (2003) component differences and configural information (spatial differences) are used to accurately recognize faces. However, inversion greatly impairs configural processing, whereas component processing seems to be unaffected.

What we don't know yet is how much extra effort is required for processing inverted faces. One approach that may be useful is to use heart measures of attention and processing. According to Lacey & Lacey (1967) heart rate decelerates during encoding, accelerates during processing, and varies by task difficulty. Heart rate should decrease more when encoding and increase more when processing an inverted face; the magnitude is often related to task difficulty and how much. The following research investigation was designed to determine if physiological measures help explain the difficulty of recognizing an inverted face. Participants received a face memory task. The experiment included two phases: learning phase and testing phase. Learning phase orientation refers to whether the faces were presented upright or inverted during the learning phase. Testing phase orientation refers to whether the faces were presented upright or

inverted during the testing phase. Familiar and unfamiliar faces were included in the testing phase to determine if inversion had an impact on the participant's ability to recognize the faces, which also added another level of difficulty. Old faces are those that were used in the learning phase. Novel or new faces are those that were unfamiliar to the participant. The independent variable was the orientation of the face, upright or inverted. The dependent variables were change in heart rate and the participants' ability to recognize which faces were old and which were novel.

This study will not only add to our understanding of face processing and memory, but it might also establish heart rate as a viable measure of attention and cognition. To this point, no one has used heart rate to study face processing. If heart rate can be established as a viable measure, it could open many doors in facial processing. It could lead to knowing more precisely what happens during the face inversion effect. It could show that faces are processed differently depending on orientation. It might also provide a better understanding of why our memory for faces is so poor. Facial recognition is not a practiced skill for many. Simply inverting a face may change the way we process it. Considering that faces are usually only seen in the same upright orientation, it's peculiar that we have the ability to recognize them at all since our memory for faces is so poor.

Heart Rate

Lacey's intake-rejection hypothesis proposes that the direction of change in heart rate is linked to the attention requirements of the participant (Duncan-Johnson & Coles, 1974). Coles (1972) states that the nature of a task can determine the direction of change in heart rate. In the experiments by Coles (1972) participants performed various visual search tasks; both the measures of cardiac and respiratory activity were recorded. The results supported Lacey's intake-

rejection hypothesis; heart rate decelerated when intake of, or attention to, the external environment was required, and heart rate acceleration for tasks where the participants had to reject the external environment. In the first experiment heart rate was slower for low discriminability tasks such as empathetic listening and visual attention, and faster for high discriminability tasks such as reverse spelling and mental arithmetic.

Turskey, Schwartz, and Crider (1970) conducted a study on patterns of heart rate and skin resistance during a digit-transformation task. The results supported Lacey's hypothesis; during the information-intake phase of the experiment heart rate decelerated and during cognitive processing heart rate accelerated. It was also found that autonomic (involuntary or unconscious) changes are related to the energy required for the simple digit-transformation task (Turskey, Schwartz, & Crider, 1970). Furthermore, a study by Cacioppo and Sandman (1978) revealed similar results that supported Lacey's hypothesis. This experiment assessed the direction and magnitude of heart rate changes related to the processing of differing levels of cognitive tasks. The researchers conducted this study to determine if heart rate was accelerating due to disturbing stimuli (e.g., math problems). Disturbing autopsy slides were used as stressful stimuli and were compared to math problems. Researchers predicted that the autopsy slides presented wouldn't require as much cognitive elaboration as the math problems. The results showed that heart rate accelerated during cognitive tasks (e.g., math problems) and decelerated during the presentation of the autopsy slides (Cacioppo & Sandman, 1978). It was also found that difficult or more cognitively demanding tasks were associated with an increase in heart rate. However, heart rate was not affected by the unpleasantness of the autopsy slides. Either math is more disturbing than cadavers or heart rate does not accelerate due to disturbing stimuli.

Not all researchers believe that heart rate is a viable measure and that there are many other influential factors for physiological changes such as, mental energy, arousal, and emotions. According to study by Salvia, Guillot and Collet (2013) the way participants perceive task difficulty affects their physiological responses. The mental energy the participant uses for the task increases autonomic nervous system (ANS) activity, which increases physiological arousal. Negative emotions such as disappointment or frustration may be associated with ANS responses (Salvia, Guillot, & Collet, 2013). Heart rate responses lasted longer when the condition of the task was difficult versus when it was easy. Task requirements or difficulty was reflected by cardiac activity and may present stress-specific responses. This finding is also consistent with results from Jonassaint et al. (2008) that negative emotions can impair the ability for information processing; this is especially true when combined with specific personality traits such as, anxiety or worry. Neuroticism and extraversion are also related to the reactivity of stressful stimuli.

Facial Recognition in Infants

Many studies have been done involving facial recognition. Cara Cashon and Leslie Cohen (2001) worked with seven-month old infants and studied their ability to identify faces. When faces were presented upright infants used facial configurations, but when they were inverted they used independent features to identify the face (Cashon & Cohen, 2001). Before six months of age infants are good at recognizing and processing faces in any orientation because they spend the majority of their time on their backs. Starting at 3 months, they begin to show a preference for upright faces. The ability to process inverted faces starts to fall apart as they begin sitting upright more often, causing them to forget and inevitably lose the ability to process inverted faces. Just like any skill, if it is not used it is lost.

The history of the face inversion effect is long and storied according to Cashon and Holt (2015). The researchers explain that preference for upright over inverted faces appears at birth and again at 3-months, this is due to a general perceptual bias for top-heavy stimuli, or those that have more elements in the upper part (Chien, Hsu, & Su, 2010). Infants become sensitive to second-order configural information or spacing changes (e.g., distance between nose and mouth, between eyes, etc.) at 5 months of age for upright but not inverted faces. Holistic processing or the integration of facial features into a single representation begins developing between 3 and 4 months of age for upright and inverted faces. It becomes specific to upright faces around 7-8 months. Seemingly, the face recognition inversion effect is developing or undergoing reorganization around 4-6 months, becoming complete around 7 months of age where the inversion effect on holistic processing was found. The key is that once infants start spending more time upright the ability to process inverted faces becomes much more difficult, which carries over into adulthood.

By studying infants researchers have been able to learn much more about the face inversion effect during early development. Cashon and Cohen (2001) tested seven-month-old infants to discern whether they used independent features or facial configurations to identify a face. This study was based on the previous finding that inversion disrupts the configural processing of faces. The researchers hypothesized that upright faces would be processed by facial configurations whereas inverted faces would be processed by independent features. The results supported the hypothesis. This experiment suggests that the recognition of an inverted face is a more difficult process and that independent features are used when identifying an inverted face.

Inversion Effect

Not only are faces harder to recognize when inverted but so are other common and complex mono-oriented objects or those that are normally seen in one orientation (Yin, 1969). When a face is inverted it's more difficult to recognize, but it is also harder to read its expression. Köhler speculated that the increased difficulty is attributable to the loss of facial expression when a face is inverted (Yin, 1969). The researcher's hypothesis was that mono-oriented objects might also be more difficult to identify when inverted. In experiments 1 and 3 participants were shown a series of pictures (objects and faces). In both the inspection and test series the orientation was the same (both either upright or both inverted). In experiment 2 the inspection was either upright or inverted, and the test was the opposite. The results showed that all materials were more difficult to recognize when presented upside down; the effect of inversion was the greatest for faces (Yin, 1969). According to Yin (1969) two factors make recognizing an inverted face more difficult: the context and familiarity that faces are only seen in one orientation (e.g., upright), and a special factor that relates to the disproportionate difficulty of inverting a face (Yin, 1969). The special factor relates only to faces and might involve how the participants tried to remember the various stimuli. The two strategies used were finding a distinguishing feature or attempting remember the picture as a whole (Yin, 1969). The first strategy was used for most of the materials and the second was used for upright faces but not inverted faces. Yin (1969) found that inversion had an effect on recognition for all mono-oriented materials, however inversion affected the recognition of faces disproportionally or significantly more. Goldstein (1965) also discussed that mono-oriented stimuli and the members of their class become harder to distinguish when in an orientation that it is not normally seen in.

Valentine (1988) reviewed several studies about face recognition, in particular to those involving the effect of inversion. These studies show that face recognition becomes impaired

when faces are inverted (e.g., Goldstein, 1965; Hochberg & Galper, 1967). Facial syntax, termed by Ellis (1986), refers to inversion disrupting the familiar pattern of the facial features (Valentine, 1988). However other studies (e.g., Yin, 1969) have provided evidence that there is a disproportionate effect of inversion on facial recognition when compared to other mono-oriented objects. It is possible this disproportionate effect only appears when the task involves recognizing a face already stored in memory (Valentine, 1988). Evidence also shows that inversion disrupts the processing of configural information. Valentine (1988) concludes that upright and inverted faces are processed differently, therefore the inversion effect is not evidence that a unique process is used in facial recognition.

Diamond and Carey (1986) attempted to isolate the source of the inversion effect and to determine if it was unique to faces alone. Four experiments were conducted with various stimuli for each (e.g., faces, dogs, landscapes, and houses). Experiment 1 was used to determine the effects of inversion on faces and landscapes; a recognition memory task was used. The researchers found that the inverted landscape stimuli were in range with the other inverted non-face stimuli previously tested. In experiments 2 and 3 researchers expected a three-way interaction between expertise (expert vs. novice participants), material, and orientation (upright vs. inverted). The materials in experiment 2 were dogs vs. faces, whereas in experiment 3 materials were dog breeds. The results showed that memory for the inverted photographs of dogs were just as difficult as faces. The answer to the question if faces were special or unique to the inversion effect was clear: no (Diamond & Carey, 1986). There was a large inversion effect on faces for all participants; however, the largest inversion effect occurred for experts on dogs. Experiment 4 revealed that the effect of inversion on faces is not dependent on the ability to distinguish the features when the stimuli are inverted, which indicates that experts represent

distinguishing features in their memory differently than novices (Diamond & Carey, 1986).

Diamond and Carey (1986) go on to suggest that a large inversion effect will occur if the

following three conditions are met: members of the class must share a configuration, members

must be able to individuate the class by second-order relational features, subjects must have

expertise to use these features.

Farah, Tanaka, and Drain (1995) also studied the face inversion effect but from a slightly

different point of view. The above studies by Valentine (1988) and Diamond and Carey (1986)

influenced Farah, Tanaka, and Drain (1995) to design two experiments to explore the underlying

cause of the face inversion effect. The purpose of the first experiment was to determine if

inversion was more effected by processing an organized whole versus processing its defined

parts. The results revealed that the non-face stimuli were encoded holistically or without

decomposition. The researchers conducted a second experiment that included replacing the non-

face stimuli with face stimuli to determine if faces, too, are processed holistically. Farah, Tanaka,

and Drain (1995) believed that the face inversion effect could be eliminated if participants

encoded faces by constituent parts. The inversion effect was present when the faces were

encoded as a whole, but not when they were encoded as separate parts. Thus, the study showed

that the inversion effect is holistic in nature, for face and non-face stimuli alike.

The purpose of this thesis project was to determine if heart rate measures of attention and

cognition (encoding and processing) might provide an explanation for the inverted face effect. In

this experiment a face memory task was assigned. Each participant experienced one of four

conditions differing on the orientation of the face presented during the learning phase (either

upright or inverted) and the orientation of the face presented in the testing phase (either upright

or inverted). Also during the testing phase, participants were shown some familiar faces from the

learning phase as well as some novel or new faces they had not seen before. Heart rate was measured throughout. The number of faces recognized during the testing phase was recorded. It is hypothesized that heart rate will change the most when processing inverted faces compared to upright, because of the increased task difficulty.

Methods

Participants & Setting

Participants. Participants were student volunteers from undergraduate courses at a public Midwest university who were offered extra credit to participate at their professor's discretion. A total of 40 participants were included in the study. Of the 40 participants 32.5% (n = 13) were men, and 67.5% (n = 27) were women. Ages ranged from 18 to 37 years old with a mean of 21.4 (SD = 3.9). Of the participants 95% (n=28) identified themselves as Caucasian, 5% (n = 2) as African American, 2.5% (n=1) as Asian, 5% (n = 2) as American Indian or Alaska Native, and 5% (n = 2) identified as other. Of the participants 82.5% (n = 33) had slept at least six hours the night before, 82.5% (n = 33) had eaten the day of, and 32.5% (n = 13) of the participants had consumed caffeine within the past three hours. No participants failed to successfully complete any part of the procedure.

Setting. The study took place in a 10' by 12' lab. The lab contained two desks separated by a large shelf. A computer, monitor, Dell laptop, and television were on the researcher's side to assist in the process of data collection. A computer monitor was on the participant's side for presenting the stimuli. A video camera connected to the television was used to observe the participant and their process throughout the experiment.

Materials

An informed consent form and a brief demographic questionnaire were used in the study (see Appendix E). A BIOPAC MP36 biomeasures recording device connected to a Dell laptop was used to record the participant's heart rate. Images were presented using HABIT presentation software on a 23"computer monitor.

Informed consent. An informed consent form was provided to the participant to read and sign. It informed them of their rights as a participant and that they could withdraw for any reason, at any time during the study.

Demographic questionnaire. A demographic questionnaire created for this study and asked questions pertaining to the participant's basic health history and daily habits.

Images. Images were derived from "The Chicago Face Database: A Free Stimulus Set of Faces and Norming Data" (Ma, Correll & Wittenbrink, 2015). This resource is free and provides over 596 faces, 306 female and 290 male, of multiple races including: Caucasian, African American, Asian, and Latino. Photographs were randomly selected using an online sequence generator (Haahr, 1998). A total of 29 images were randomly selected from the database. The first 24 selected were used during the learning phase. The other five photos were used during the testing phase along with five that were randomly selected from the learning phase. Images were all adjusted to the same dimensions (10.18" by 7.16") and resolution (100 pixels/inch) to ensure consistency. The sequence that the participant viewed during both the learning and testing phase was randomized. Images were either presented all upright or all upside down during each phase.

BIOPAC. BIOPAC research systems have been used for physiological measurements and interpretation solutions on both humans and animals (BIOPAC, 2017). Researchers are successfully able to acquire, analyze, and interpret data using BIOPAC systems. The system used in this experiment was the BIOPAC MP36 with AcqKnowledge software, which includes automated analysis routines for ECG, HRV, EEG, EMG, EGG, ect. By using electrodes, electrode leads, cables, transducers, and stimuli, data can be easily acquired. The Human Anatomy and Physiology Society (HAPS) ranks this program and its software number one for physiology experiments (BIOPAC, 2017). The data collected was coded within this program. A marker was placed for each stimulus presented during the experiment. Beats Per Minute (BPM) was coded for the first complete three R waves after each marker.

Procedure

The study was announced in undergraduate psychology courses and student volunteers signed-up on the bulletin board outside the Psychology Department. Each experimental session lasted about 20-30 minutes. Data were collected for approximately two weeks. Participants were greeted in the Psychology Department lounge by the researcher. They were then escorted back to the 10' by 12' lab. The researcher explained the purpose of the study and the experiment's procedure. An informed consent form was provided and signed before continuing with the study. The participant filled out a demographic questionnaire before being seated in front of the 23" monitor. Once seated, three sensors were applied to the participant, one on the inside of each ankle and one on the right wrist. The procedure included two phases and participants were randomly assigned one of four conditions.

Conditions. A total of four conditions were used in the present study: Upright/Upright (UU), Upright/Inverted (UI), Inverted/ Upright (IU), and Inverted/Inverted (II). These conditions refer to the orientation of the visual stimuli during the learning phase and the testing phase. A total of 10 participants were randomly assigned to each condition before the experiment began.

Learning phase. Before the learning phase began, the participant was given instructions that outlined the procedure and their tasks during the experiment (see Appendix D). A two-minute baseline of resting heart rate was recorded. The experiment began when the word "ready" presented for about 5-seconds, followed by a 7-second blank screen. Following the blank screen were 24 7-second photographs of faces, between each image a blank screen appeared for 7-seconds. During the learning phase the participant's task was to memorize or try to learn the faces presented. For the UU and UI condition the 24 faces appeared upright. For the IU and II conditions they appeared inverted.

Testing phase. During the testing phase 10 images were presented in a random order. Of the 10 faces, five were familiar (old) and five were novel (new). The conditions of UU and IU were presented with 10 upright faces. The UI and II conditions were presented with 10 inverted faces. The participants were informed that some of the images would be old and some would be new. Each face was presented for approximately 7-seconds, with a 7-second blank screen between each. Once the image disappeared, the participant was instructed to determine whether the face was familiar or novel by saying out loud "old" or "new" before the next image was presented.

Once the experiment was complete, the sensors were removed from the participant. A debriefing statement was read aloud to the participant explaining the purpose and goals of the

study. A paper copy of the debriefing statement was given to the participant, which included

future contact information should they have any questions or concerns.

Results

The first analysis determined which orientation, upright or inverted, was harder to learn.

The mean heart rate while participants viewed the upright or inverted faces during the learning

phase were compared. This comparison was achieved by calculating the mean difference score

between the participant's baseline heart rate and their heart rate while observing the stimuli. The

mean heart rate was compared to the both the upright and/or inverted faces for each of the

participants. The mean difference score was calculated for upright ($M = -2.00$, $SD = 6.94$) and

inverted ($M = -.302$, $SD = 5.66$) conditions. An independent samples t-test was used to compare

those means. The difference was not significant, $t(38) = -.847$, $p = .402$.

The second analysis investigated heart rate changes while processing upright faces,

inverted faces, and whether heart rate changes over time. The participant's mean heart rate while

looking at the faces was compared to their resting heart. For analysis the learning phase was

divided into three stages of learning: early, middle and late. Each segment contained eight trials:

early learning (trials 1-8), middle learning (trials 9-16), late learning (trials 17-24). The mean

heart rate was calculated for each segment for both upright and inverted conditions. Upright:

early learning ($M = -1.38$, $SD = 6.49$), middle learning ($M = -2.54$, $SD = 7.44$), and late learning

($M = 2.04$, $SD = 7.63$). Inverted: early learning ($M = 1.21$, $SD = 6.68$), middle learning ($M = -.93$,

$SD = 5.19$), late learning ($M = -.91$, $SD = 6.40$). The means of each segment were compared to

zero using a series of single sample t-tests. The participant's heart rate when viewing upright

faces was not significantly different from their resting heart rate: early learning $t(19) = -.952$, $p =$

.353, middle learning $t(19) = -1.523$, $p = .144$, and late learning $t(19) = -1.195$, $p = .247$. Heart

rate while observing inverted faces was not significantly different from resting heart rate: early

learning $t(19) = .808$, $p = .429$, middle learning $t(19) = -.804$, $p = .432$, and late learning, $t(19) =$

$-.635$, $p = .533$. See Figure 1 in Appendix C for mean heart rate difference for upright and

inverted faces during each segment.

The third analysis compared heart rate during the testing phase between old and new

faces, and upright and inverted faces by their orientation during the learning phase and testing

phase. This analysis was used to determine if the differing means were due to chance or not. The

mean difference score was calculated for all four conditions. A three-way analysis of variance

(ANOVA) with repeated measures on the last factor was conducted. The first factor was the

learning phase orientation: upright or inverted. The second factor was the testing phase

orientation: upright or inverted. The third factor was whether the face was old or new during the

testing phase. The main effect of the testing phase orientation was not significant. For heart rate

there were no significant differences between learning upright or inverted faces during the

testing phase, $F(1,36) = 1.198$, $p = .281$. The main effect for testing phase orientation was also

found to be not significant, $F(1,36) = .187$, $p = .668$; the type of face (old or new) did not affect

heart rate during the testing phase. The main effect of old vs. new during the testing phase was

not significant, $F(1,36) = 1.074$, $p = .307$. The combined comparisons revealed that the

combination of upright and inverted, as well as old and new faces all appeared to be experienced

similarly. No interaction of learning phase orientation, testing phase orientation, and old vs. new

during testing phase approached any significance. See Table 1 in Appendix C for relevant means

and standard deviations.

In the UU condition participants recognized 91% ($M = 9.1$, $SD = 0.7$) of the face accurately and in the UI condition 82% ($M = 8.2$, $SD = 1.3$). For the IU condition only 79% ($M = 7.9$, $SD = 1.4$) were recognized and 89% ($M = 8.9$, $SD = 0.9$) were accurately remembered in the II condition. See Figure 2 in Appendix C for the average number recognized in each condition. For the final analysis a two-way ANOVA was conducted, which determines if there are any main effects (effect of one independent variable ignoring all others) or if there was an interaction (effect of one independent variable depends on the level of the other independent variable) between the two independent variables on the dependent variable. The first factor was the orientation of the face during the learning phase: upright or inverted. The second factor was orientation of the face during the testing phase: upright or inverted. The dependent variable was the number of faces correctly recognized. There was no significant main effect of orientation during learning, $F(1,36) = .486$, $p = .490$. There was also no significant main effect of orientation during test, $F(1, 36) = .019$, $p = .890$. There was a significant interaction between learning orientation and testing orientation, $F(1, 36) = 7.017$, $p = .012$. With participants in the upright learning condition doing better with upright faces during test, while participant in the inverted learning condition did better with inverted faces during test. When faces were presented upright, participants recognized significantly more faces when they learned them upright versus when they learned them inverted. However when presented with inverted faces, participants recognized significantly fewer faces when they learned them upright versus when they learned them inverted. A change in orientation between learning and testing phases resulted in fewer faces correctly recognized. See Figure 3 in Appendix C for interaction between learning orientation and testing orientation.

Discussion

The purpose of the present thesis was to determine if heart rate measures of encoding and processing could provide an explanation for the inverted face effect. The results do not seem to support the original hypothesis that heart rate would change the most when processing inverted faces when compared to processing upright faces. Heart rate did not significantly change during the duration of the study. The first analysis determined which orientation was harder to learn: upright or inverted. There was no significant difference in heart rate for orientation during the learning phase, which suggests that learning inverted faces may not require more encoding or processing than upright faces. However, past research reveals that learning inverted faces is more difficult than learning upright faces (e.g., Diamond & Carey, 1986; Valentine, 1988; Yin, 1969), and that heart rate is a viable measure of encoding and processing (e.g., Cacioppo & Sandman, 1978; Coles, 1972; Turskey, Schwartz, & Crider, 1970). This discrepancy suggests that heart rate may not be a viable measure for facial processing and recognition in the current study. It may be possible that heart rate is a viable measure when applied to other theories of facial recognition such as, context and strategy use. The second analysis investigated heart rate changes while processing upright faces, inverted faces, and if heart rate changes throughout the experiment. The learning phase was divided into three segments to account for the possibility of any changes of heart rate when learning is new and may be harder than when it is old and practiced. No significant differences were found in the participant's heart rate while viewing upright faces or inverted faces when compared to baseline heart rate.

The third analysis took many things into consideration when it came to heart rate in the testing phase. The first main effect was the orientation of the stimuli during the learning phase and if orientation affected the participant's heart rate. The second main effect looked at the orientation during the testing phase and if orientation affected heart rate. The third main effect

tested was whether the faces presented during the testing phase were old or new and whether this affected heart rate. The results showed that none of these main effects were of significance and that any difference in the means was likely due to chance. No interactions were found among any combination of these tests.

In the final analysis there was no significant main effect found for orientation in either the learning phase orientation or the testing phase. Whether the participant was presented with upright or inverted faces did not matter; both recognized the same number of faces. However, there was a significant interaction between learning orientation and testing orientation. The participants under the UU condition got significantly more correct than those under the UI condition. Also, participants assigned the II condition got significantly more correct than those assigned the IU condition. When the orientation was flipped between the learning phase and the testing phase; the task quickly became more difficult. These findings are consistent with research conducted by Yin (1969), which revealed that not only were inverted faces harder to recognize but so, too, were other mono-oriented objects. However, the inversion effect was greatest for faces.

The results off the current study were insignificant and were likely due to chance. If mechanical error was reduced it is possible that the standard deviations would be lower. Mechanical error could be reduced by observing and taking note of participants' behavioral (e.g., tapping feet, excessive fidgeting or movement, etc.), emotional (e.g., stressed, anxious, etc.), and physical (e.g., tired, fatigued, etc.) states, and by being more vigilant of what information is provided to the participants. With a lower standard deviation and an increased n value, it is possible that the F value would have been high enough to reject the null and accept the alternative. It is also possible that the participants' mental energy, arousal, and emotions

countered any evident change in heart rate (Salvia, Guillot, and Crider, 2013). For example, the mental energy needed to complete the face memory task could have increased physiological arousal, even though a decrease was expected when processing upright faces, thus potentially counteracting any change.

Although the results were null, trends can still be found from the data found in Table 1 in Appendix C. It appears that when participants were presented with upright faces during the learning phase their heart rate tended to decelerate. When participants were presented with inverted faces in the learning phase their heart rate tended to accelerate. The data are headed in the right direction but lack statistical significance. Heart rate acceleration was expected when processing inverted faces because they are more difficult to process. Since upright faces are much easier to process because it requires mainly encoding, a deceleration in heart rate was expected. Turskey, Schwartz, and Crider (1970) demonstrated that cardiac activity reflects task requirements; with results that agreed with Lacey's hypothesis. It may be that the face memory task used was simply not difficult enough to produce significant results.

Results are consistent with the part of the findings of Hochberg and Galper (1967). In both studies inverted faces were much harder to process than upright faces, which is in concordance with several other studies (e.g., Goldstein, 1965; Yin 1969). Cashon and Holt (2015) found that, along with newborns, three-month-olds already had a preference for upright faces. The comparison between upright-viewing (learning) and upright-recognition (testing), and inverted-viewing and upright-recognition yielded no significant differences in accuracy in the Hochberg and Galper (1967) study. However, in the current study there were differences in accuracy between conditions, thus creating a significant interaction between learning orientation and testing orientation.

Limitations

The results of this study may be limited by a few different factors. By only using 24 faces in the learning phase and 10 in the testing phase could have made the task easier for participants to complete. Increasing the number of images used during the learning and testing phase would increase diversity among the faces and may increase task difficulty. The differences in the faces chosen at random may have been too distinctive from one another. Including more images could make the faces less distinctive, possibly due to the increase in stimuli to process. If the faces were more similar it would most likely make the face memory task more difficult. The study also was limited on time for data collection. With more time, the sample size could be much larger, and may have provided significant results. The data seemed to be headed in the predicted direction, however it lacked statistical power. Participants were also limited to undergraduate student volunteers at a public Midwest university. A much larger, more diverse group of participants could have led to significant results. Overall, by using more stimuli during both the learning and testing phase, using a larger, more diverse sample, and collecting data for a longer period of time, less variability may have surfaced in the data and might have more statistical power.

Conclusion

To add to our understanding of facial processing the current research attempted to establish heart rate as a viable measure of attention and cognition. A decrease in heart rate was expected when processing upright faces; whereas acceleration in heart rate was expected when processing inverted faces. These changes were expected due to the evidence from preceding studies that inverted faces are much more difficult to process than upright faces. However, data

showed that heart rate did not seem to significantly change from baseline throughout the learning and testing phases. Upright and inverted, and old and new images seemed to be experienced similarly according to heart rate measures of attention and did not seem to cause any changes in encoding and processing. However, the data did show that is more difficult to recognize faces when learned one way and tested another.

Although the results were null, trends can still be found among the data. The data are in the predicted direction but weren't powerful enough to provide significant results. Future researchers should consider using more stimuli in both the learning phase and the testing phase. By using more stimuli, task difficulty and similarity among the images may increase. The other limitations of this study should also be considered for further research. Using a larger, more diverse sample could greatly impact the results. More research is needed to discern the physiological impact from the face inversion effect.

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Appendix A

Whitney Walker-O'Beirne

Honors Proposal Thesis

Heart Rate and the Face Inversion Effect

Advisor: Dr. Keith Gora

November 9, 2015

Bemidji State University

Introduction:

The face inversion effect is one of the most studied phenomenons in facial recognition. People are excellent face processors but the ability falls apart when a face is inverted. The face inversion effect refers to the difference between upright and inverted faces in recognition and other aspects of facial processing (Cashon & Holt, p. 119). Facial recognition is a "special" process according to Yin (1969). Upright faces are much easier to recognize than upside-down or inverted faces. This is because we have to ability to recognize upright faces as a quickly processing unit whereas upside down faces are processed as a set of parts (eyes, nose, mouth, etc.). What we don't know yet is how much extra effort is required for processing inverted faces. Are there parts as recognizable as the whole and vice versa? One approach that may be useful is to use heart measures of attention and processing. The following proposal explains how we might use these measures to determine how much harder it is to recognize a face and its parts.

In this study, participants will be asked to memorize a set of faces, either upright or inverted, and then tested using faces that are either upright or inverted. A two-minute resting heart rate will be recorded before the experiment begins. Heart rate will be measured throughout. The learning phase will require two experimental groups who are to memorize the faces that appear. Each face will be shown for twenty seconds. Group 1 will be presented with ten upright faces and Group 2 will be presented with ten inverted faces. Once the learning phase is complete the participants will move onto the test phase. During the test phase both groups will be divided in half. Half of the participants will see ten upright faces: five being familiar and five being novel. The other half will be presented with ten inverted faces: five being familiar and five being novel. Each participant is to identify which faces they had previously learned. Heart rate

should decrease when encoding and decrease when processing. The magnitude is often related to task difficulty and how much.

Many studies have been done involving facial recognition. Cara Cashon and Leslie Cohen worked with seven-month old infants and how they were able to identify faces. When faces were presented upright infants used facial configurations, but when they were inverted they used independent features to identify the face (Cohen, 2001, p. 89).   Infant's ability to recognize faces depends on their age, initially they are good at processing faces in any orientation. Starting at 3 months, they have a preference for upright faces. The longer the infant spends upright they start to lose their ability to process inverted faces. Other studies have stated that inverted mono-oriented objects, those that are normally seen in one orientation, are harder to recognize. The effect of inversion was the greatest for faces (Yin, 1969, p. 142). Anything special for these objects or faces may be lost with inversion.

This study has a dual purpose. It will add to our understanding of face processing and memory, but it will also establish heart rate as a viable measure of attention and cognition. It will also help us better understand why our memory for faces is so poor. Considering we usually only see faces in the same orientation, it's a wonder that we recognize them at all. Facial recognition in general isn't an easy task for most people, by changing the image's orientation from upright to upside-down can change the way we process the image. By adding unfamiliar faces to the test phase it will add another level of difficulty.

Literature Review:

The history of the face inversion effect is long and storied according to Cashon and Holt (2015). The face inversion effect is defined as the differences between upright and inverted faces in recognition as well as to other aspects of face processing. Cashon and Holt explain that

preference for upright to inverted faces appears at birth and again at 3-months. This is due to a general perceptual bias for top-heavy stimuli. At 3-5.5 months their preference for upright faces shifts to a more face-specific specialization. Infants become sensitive to second-order configural information (spacing changes) at 5 months of age for upright but not upside down faces. Between 3 and 4 months holistic processing of upright and inverted faces is developing and becomes specialized for upright faces around 7-8 months. It is suggested that the face recognition inversion effect is developing or undergoing a reorganization around 4-6 months. Becoming complete around 7 months of age, where the inversion effect on holistic processing was found. The key here is that once infants start spending more time upright they lose the ability to process inverted faces, which carries over into adulthood.

Much of what we know about the face inversion effect has been learned by studying infants. Cashon and Cohen (2001) tested seven-month-old infants on whether they used independent features or facial configurations to identify a face. This study was based on the previous finding that inversion disrupts the configural processing of faces. It was hypothesized that upright faces would be processed by facial configuration whereas inverted faces would be processed by independent features. The results supported their hypothesis. This experiment is evidence that the recognition of an inverted face is a more difficult process and that independent features are used when identifying an inverted face.

Not only are faces harder to recognize when inverted but so are other common and complex mono-oriented objects (Yin 1969). "Kohler not only noted this, but also speculated that the difficulty was attributable to the loss of 'facial expression' in the inverted picture." (Yin, p. 141). When you invert a face it's harder to recognize, but it is also harder to read its expression. The hypothesis for this being that anything mono-oriented may be more difficult to identify

when inverted. In experiments 1 and 3 participants were shown a series of pictures (objects and faces). In both the inspection and test series the orientation was the same (both either upright or both inverted). In experiment 2 the inspection was either upright or inverted, and the test was the opposite. The results showed that all materials were more difficult to recognize when presented upside down, especially faces. Everything special about faces may be lost when inverted, as well as for common familiar objects.

 A variety of different studies have provided evidence that there is a disproportionate effect of inversion on facial recognition (Valentine, 1988). Several studies state that face recognition is impaired when inversed. These studies are collective, giving you a better understanding of how facial recognition might work. Ellis (1986) termed the facial syntax-inversion disrupts the familiar pattern of the facial features (Valentine, 1988, p. 472). The disproportionate effect of inversion leads to the conclusion that face recognition is a "special process" that is not involved in recognizing an inverted face. There is evidence that shows that the processing of configural information is disrupted by inversion.

The nature of a task can determine the direction of change in heart rate (Coles, 1972). In these experiments participants performed various visual search tasks, both the measures of cardiac and respiratory activity were recorded. The results supported J. I. Lacey's intake-rejection hypothesis; heart rate decelerated when intake of, or attention to, the external environment was required, and heart rate acceleration for tasks where the participants had to reject the external environment. In Experiment I heart rate was slower for low discriminability tasks such as empathetic listening and visual attention, and faster for high discriminability tasks such as reverse spelling and mental arithmetic.

Methods:

   This research thesis will be an experiment to determine if heart rate provides a physiological measure of task difficulty. It is a step beyond processing speed. In this experiment a face memory task will be used. The Institutional Review Board will evaluate this study for the use of human subjects before experimentation begins. Participants will be presented with faces and their task is to determine which faces are new and which are old. The independent variable will be whether the image presented is upright or inverted. The dependent variables will be changes in heart rate and the participants' ability to determine which faces are familiar and which are novel.

   Participants will be students from Bemidji State University. Before the experiment begins each participant will fill out a brief demographic of questions pertaining to the heart and will be informed of the nature of the experiment. Participants will be seated in a chair with three electrodes attached, one on each ankle and one on the wrist. A two-minute resting heart rate baseline will be recorded. There will be two groups each consisting of 30 participants for the learning phase. In the testing phase Group 1 and Group 2 will both be separated into two subgroups of 15.

   During the learning phase Group 1 will be presented with 10 upright faces for 20 seconds each. The task is to try remembering the faces that are shown. In the test phase the group will be divided into two. The first half will be presented with 10 upright faces, five images being familiar and five images being novel. The second half will be presented with 10 inverted faces, five images being familiar and five images being novel. The task is to identify which faces are familiar and which faces are novel. The same process will be used for Group 2 except in the learning phase they will be presented with 10 inverted faces.

After all the data has been collected, it will be entered into SPSS to be analyzed as a 2x2 ANOVA or also known as a Dependent T-test. The first factor will be upright or inverted during the learning phase and the second factor will be upright or inverted during the test phase. Reaction time will also be measured, participants will press right if familiar and left if novel. I will then be able to make comparisons among groups and determine if any results were significantly significant. I will analyze any heart rate changes during encoding and retrieval, and how accurate the participants were able to recognize a familiar face.

Timeline:

December-January: Submit application to the Institutional Review Board and complete   the online ethics training.

February: Begin collecting images to be used in the experiment. Add source information. Put up sign-up sheet for students to participant.

March: Start conducting and obtaining data for the experiment.

April: Enter data into SPSS and do a Paired Sample T-test.

May: Analyze data and report findings.

June: Add tables into the results of my thesis.

July: Begin writing rough draft.

August: Make sure all sources are valid and are cited properly.

September: Edit thesis. Meet with my advisor and begin making revisions for final draft.

October-November: Finalize project by making any last revisions to project. Have advisor proof read the final draft. Begin preparing for presentation.

December: Submit project.

References

Cashon, C., & Holt, N. (2015). Developmental Origins of the Face Inversion Effect. Advances in Child Development and Behavior, 117-150**.**

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Coles, M. (1972). Cardiac and Respiratory Activity During Visual Search. Journal of Experimental Psychology, 96(2), 371-379.

Valentine, T. (1988). Upside-down faces: A review of the effect of inversion upon face. *British Journal of Psychology*, *79*(4), 471.

Yin, R. K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology, 81*(1), 141-145.

Appendix B

Human Subjects Committee (HSC) Submission Checklist
PLEASE SUBMIT WITH PROPOSAL TO SCHOOL OF GRADUATE STUDIES
Deputy Hall 111

Project title: Heart Rate and the Face Inversion Effect

Principal Investigator(s):   Whitney Walker-O'Beirne

The HSC will NOT review proposals that do not include:
Applicable/Not-Applicable*

1. Completed HSC Human Research Approval Form and Ethical   ☒   Applicable
   Compliance Questionnaire (See Section A) and attach it to the
   documents being submitted for review.

2. A 100-150 word abstract or summary of the proposed study.   ☒   Applicable

3. A complete statement of the research methods, including copies
   of the instrument(s) being used to collect data. (Do not include ☒   Applicable
   literature review chapters or proposals.)

4. Informed Consent Form(s) – See Section B for further   ☒   Applicable
   description and sample consent form.

5. Signed letter of permission from institution if research to be   ☐

   conducted is in an institution such as school, hospital, etc.   Not-Applicable

6. Debriefing Statement – See Section C for further information   ☒   Applicable
   and sample (minimal risk proposals need to include this form).

7. a) The original and one (1) copy of this information are required ☒   Applicable
      for an Expedited Review.

                    OR

   b) The original and six (6) copies of this information are required ☐   Not-Applicable
      for a Full Review

8. CITI Collaborative Institutional Training Initiative Certificate of
     Completion   ☒   Applicable
     [All investigator(s) and faculty/sponsor are required to complete]

*Please indicate those items not applicable. Thank you.

APPROVAL FORM AND ALL ATTACHMENTS MUST BE TYPED!

Bemidji State University/Northwest Technical College
Human Subjects Committee
Human Research Approval Form

Title of Study: Heart Rate and the Face Inversion Effect

Date Submitted: 07/31/16   Project starting date: 09/01/16   Project ending date: 12/08/16

Principal Investigator(s):   Whitney Walker-O'Beirne   BSU Student
ID#, if applicable:
11138850

Please indicate if you are: BSU/NTC Faculty   BSU/NTC Student(s) X   Non-BSU/NTC

Have all <u>Principal Investigators</u> listed completed the training for Human Subjects research? X
Yes   No

Street Address: 9405 Chad Dr NW   Telephone: (218)308-1995

City, State, & Zip Bemidji, MN 56601

E-mail Address: walk1whi@live.bemidjistate.edu

Co-Investigators:

Faculty Advisor/Sponsor: Keith Gora

Request: ☒ Expedited Review (include reasons below)   ☐ Full Review   ☐
          Exempt (include reasons below)

The research contains no risks greater than those encountered in daily life.

Is the submitted document in **draft** form yet to be pre-tested?   ☐ Yes   ☒ No
(If Yes, a final copy of the survey instrument must be re-submitted upon completion.)

Can the title of this study be made public before the completion date?   ☒ Yes   ☐ No
Are you using BSU and/or NTC students for this study?   ☒ Yes   ☐ No

The student's faculty advisor must first approve all student research. Signature denotes the advisor's approval of the project and must be obtained prior to forwarding to the HSC in the School of Graduate Studies.

_____   _____
          Signature of Advisor/Sponsor   Date | For office use only:

Has the Advisor/Sponsor completed the training for Human Subjects research? ___ Yes   ___ No

----

HUMAN SUBJECTS COMMITTEE RECOMMENDATION:

_____   Exempt Review

          _____ Approved   _____ Revise and resubmit   _____ Not approved

_____   Expedited Review

          _____ Approved   _____ Revise and resubmit   _____ Not approved

_____   Full Review

          _____ Approved   _____ Revise and resubmit   _____ Not approved

_____   _____
HSC Reviewer's Signature   Date
                          Ethical Compliance Questionnaire

Complete all items on this form and/or on separate sheets of paper attached to this form.

I.   Subject Recruitment and Requirements (includes subjects recruited for pre-testing).

    1.   What type of human subjects will you require? (gender, age, location, affiliation, special characteristics)

          Undergraduate psychology students from Bemidji State University, all genders, age 18+, no special charactersistics.

    2.   Where and how do you propose to recruit participants/subjects?

          Student volunteers from undergraduate psychology courses at Bemidji State University.

    3.   If your study involves subjects in institutions (schools, hospitals, other agencies), how will institutional consent be obtained? A single letter of permission from an institutional representative is required. Attach original copy to the proposal. See Sample Permission Letter.

          Not required if you are using Bemidji State University and/or Northwest Technical College human subjects. However, notification of the survey will be provided to the VP for Student Development & Enrollment after IRB approval is secured.

4a.   Will your study use minors (subjects under 18 years of age)?
☐   Yes   If "Yes" proceed to 4b.

☒   No   If "No", explain how you will ensure that minors will NOT complete
your study. i.e. The first question in your survey should ask participants to identify their
age. If under the age of 18 years, they should be instructed NOT to complete the survey.

It will be stated on the informed consent form that it is required that they are at least 18
years of age, if they are under the age of 18 years they will be instructed to not
participate.

Proceed to 5a.

4b.   How will consent be obtained if subjects are minors and/or incapable of giving
legal consent?

4c.   Is informed consent form attached? ☐ Yes   ☐ No

5a.   If subjects are of legal age, how will consent be obtained?

Verbal and signed informed consent form.
5b.   Is informed consent form attached?   ☒ Yes   ☐ No

 6.   How much time will be required of each participant?

Approximately 30 minutes

7a.   Will subjects be compensated for participation? ☒ Yes   ☐ No

7b.   If yes, please specify:

Students may be offered extra credit by their instructor.

8a.   Is confidentiality assured? ☒ Yes   ☐ No

8b.   If Yes, how? (i.e. Signed Informed Consent forms and raw data will be stored separately in a locked cabinet in the Faculty/Sponsor's office; no names or other identifying items will be connected to the study instrument.

Signed Informed Consent and data will be stored separately in a locked file cabinet Dr. Gora's office. No names or other identifying items will be connected to the study instrument.

8c.   If no, why not?

9.   What benefits do subjects obtain by participating?

It is unlikely that this study will provide them with direct benefits. Their participation will make an important contribution to our scientific knowledge of heart rate and face recognition.

II.   Subject Risk

Certain practices are generally to be avoided. If any are included in the proposed study, check the blank next to the appropriate category and justify with attachments.

☐ Deception   ☐ Pain, threat, or aversive stimulation

☐ Embarrassment   ☐ Invasion of privacy

None

III.   Debriefing

1.   When and how will subjects be provided with feedback about the study?

Participants will be debriefed upon completion of the task.

2a.   Is a debriefing form attached?   ☒ Yes ☐ No (Include debriefing statement when applicable; minimal risk proposals must include this form)

2b.   If deception has been used, how will the subject be informed?

2.   What follow-up supports will be available if subjects experience undesirable consequences of participation? (ONLY BSU students may be referred to the BSU

Counseling Center; all others (including NTC students) must be referred to an agency outside of BSU).

If participants experience undesirable consequences they will be referred to the BSU Counseling Center.

IV.   Materials

1.   What questionnaires, inventories, tests, or other instruments will be used? Attach copies unless the instrument is universally familiar.

Attached demographic form

2.   What electrical, electronic, or mechanical equipment will be used? If any have been specially constructed or modified for use in this study, provide a description with sufficient detail so that any physical danger may be assessed. Supplementary documents may be attached if necessary.

Heart rate will be recorded using a BIOPAC System Inc. MP36 biomeasures recorder. Two sensors will be placed on each ankle and one on the right wrist. This is an established system designed to for student lab use and a tried and safe protocal.

FEDERAL GUIDELINES REQUIRE ALL RECORDS AND DATA BE KEPT FOR THREE YEARS.

Completed HS proposals should be submitted to the HS Committee in the School of Graduate Studies. Once submitted, please allow ten (10) business days for review and/or approval.

Updated 5/28/2015

Abstract

The face inversion effect is one of the most studied phenomena in facial recognitions. People are excellent face processors but the ability falls apart when a face is inverted. The purpose of this study is to determine if they fall apart due to difficulty encoding the faces or due to processing them. According to Lacey & Lacey (1967) heart rate decelerates during encoding, accelerates during processing, and varies by task difficulty. It is hypothesized that heart rate should change the most when processing inverted faces compared to upright, because of the increased task difficulty. It is further hypothesized that if participants fall apart during encoding, heart rate will decrease more during the inverted task, while if they fall apart during processing it will increase more.

Methods

Purpose

The purpose of this research thesis will be an experiment to determine if heart rate measures of encoding and processing might provide an explanation for the inverted face effect. In this experiment a face memory task will be used. Participants will be presented with faces and their goal is to determine which faces are new and which are old. The independent variable will be whether the image presented is upright or inverted. The dependent variables will be changes in heart rate and the participants' ability to determine which faces are familiar and which are novel.

Participants & Groups

Participants. Participants will be students from Bemidji State University. There will be 40 participants total. Students will sign-up for participation through Dr. Keith Gora.

Groups. Of the 40 participants, 20 will be randomly assigned to Group1 and Group 2 before the learning phase. The orientation of the visual stimuli will be presented differently for each group. Groups 1 and Group 2 were further divided into subgroups of 10 participants for the testing phase. The visual stimuli will also be presented differently depending on subgroup. There will be four groups of ten total: Group 1A, Group 1B, Group 2A, and Group 2B.

Materials & Setup

Materials. Before the experiment begins, each participant will fill out a brief demographic of questions pertaining to their basic health history and daily habits, and will be

informed of the nature of the experiment. A BIOPAC MP36 biomeasures recording device connected to a Dell laptop will be used to record the participant's heart rate. Images will be presented on a 23" computer monitor using HABIT presentation software.

Setup. After the participant has given both verbal and written consent, they will be escorted to the recording lab and seated at a desk with a computer monitor. Three sensors will be attached to the participant, one on each ankle and one on the right wrist. A two-minute baseline of resting heart rate will be recorded.

Procedure

Learning phase. During the learning phase, Group 1 will be presented with 10 upright faces for 20 seconds each. Group 2 will be presented with 10 inverted faces. The participant's task is to memorize the faces that are shown.

Testing phase. In the testing phase both Group 1 and Group 2 will be divided into equal subgroups of 10. Group 1A and Group 2A will be presented with 10 upright faces, five images being familiar and five images being novel. Group 1B and Group 2B will be presented with 10 inverted faces, five images being familiar and five images being novel. Participants will be instructed to press right if familiar and left if novel on the keyboard. The task is to identify which faces are familiar and which faces are novel.

After all the data has been collected, it will be entered into SPSS to be analyzed. The first factor will be upright or inverted during the learning phase and the second factor will be upright or inverted during the test phase. I will then be able to make comparisons among groups and determine if any results were significantly significant. Any heart rate changes during encoding

and retrieval, and how accurate the participants were able to recognize a familiar face will be

analyzed.

SECTION B: Informed Consent

You are invited to participate in an experiment titled "Heart Rate and the Face Inversion Effect" conducted by Whitney Walker-O'Beirne of the Psychology Department at Bemidji State University under the supervision of Dr. Keith Gora.

Purpose of the study: The purpose of this study is to determine if heart rate provides a physiological measure of task difficulty. Heart rate and cognition are strongly tied. Cognition can influence heart rate and vice versa. We are interested to see if we can use heart rate as a measure of face processing ability.

Requirements: You must be at least 18 years of age to participate.

Procedures: You will be asked to fill out a demographics form. To monitor your heart rate; three sensors will be attached, one on each ankle and one on the right wrist. You will be asked to memorize a set of faces and then be presented with another set. You will identify which faces you had seen previously.

Confidentiality: All data obtained will remain confidential. Your name will not appear on any of the test materials or be associated with individual data-all results will be reported in a group format only. We ask that you fill out the attached demographic sheet so we are able to obtain specific characteristics of the sample.

Risks: It is not likely that you will experience any form of risk during the study, but if that should occur, please contact Dr. Troy Gilbertson, Dean of the College of Health Sciences and Human Ecology, at (218) 755-2965. If questions arise after you have left our lab, please call Dr. Keith Gora at (218) 755-2882.

Benefits: You will receive one hour's worth of extra credit for your participation. Your participation will make an important contribution to our scientific knowledge of heart rate and face recognition

Freedom to Withdraw: You are free to decline to participate or to withdraw your consent and discontinue participation at any time. There are no penalties for withdrawing, however, if you are receiving extra credit, your instructor may require an alternate activity before granting credit.

If you have any questions about this study, you may ask them before, during, or after participation.

You signature below indicates that you have read the information above, you are at least 18 years of age and you have decided to participate. You may withdraw at any time without prejudice after signing this form, should you choose to discontinue.

_____   _____   _____

Name (please print)   Signature   Date

SECTION C: Debriefing

The purpose of this study was to determine if heart rate provides a physiological measure of task difficulty. Based on the results of previous research, my hypothesis is that heart rate will decrease when encoding and increase when processing. Previous research indicates that heart rate decelerates during encoding, accelerates during processing, and varies by task difficulty. In the task you just completed, heart rate should increase the most when processing inverted faces because of the increased task difficulty.

The results of this study will be posted on the Psychology Department bulletin board in May 2017. Your performance results will be available to you after the completion of the task (e.g. number of correct answers). If you have any questions or you would like more information about this study, please contact me, Whitney Walker-O'Beirne or Dr. Gora, in the Psychology Department (218) 755-2880. It is not expected that you will suffer any adverse effects from this study. If that should happen please contact Dr. Troy Gilbertson, Dean of the College of Health Sciences and Human Ecology, at (218) 755-2965, or BSU Counseling Center, at (218) 755-2053. Thank you for participating in the Heart Rate and the Face Inversion Effect Study.

Demographic Questionnaire   Participant's Subject #:_____

  A. Background Information

      1. Age:_____ Gender:_____

      2. When was the last time you ate?_____

      3. Approximately how many hours did you sleep last night?_____

      Is that your usual amount? Yes ( ) No ( ). If no, explain_____

      _____

      4. Have you had caffeine in the past 3 hours? Yes ( ) No ( )

      If yes, approximately how much?_____

      Is this your usual amount? Yes ( ) No ( )

      If no, how much is usual?_____

      5. Are you currently taking any prescription or over the counter drugs or medications?

      Yes ( ) No ( ) If yes, please explain_____

      _____

      6. How many hours a week do you work a job?_____

      7. How many credit hours are you presently taking?_____

      8. What is your present GPA?_____

  B. Participant's Health Record

      1. Do you wear glasses or contacts? Yes ( ) No ( )

      If yes, are you wearing them now? Yes ( ) No ( )

      If you wear them but are not wearing them now, please explain_____

      _____

      2. Do you exercise or workout? Yes ( ) No ( )

      If yes, how often?_____

      3. Have you ever been hospitalized? Yes ( ) No ( )

      If yes, please explain_____

      _____

      4. Do you have any chronic health problems or conditions? Yes ( ) No ( )

      If yes, please explain_____

      _____

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)
COURSEWORK REQUIREMENTS REPORT*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details.
See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Whitney Walker-O'Beirne (ID: 5345324)
- **Email:** walk1whi@live.bemidjistate.edu
- **Institution Affiliation:** Bemidji State University (ID: 2958)
- **Institution Unit:** Psychology

- **Curriculum Group:** Social & Behavioral Research - Basic/Refresher
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Basic Course
- **Description:** Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in Social/Behavioral Research with human subjects.

- **Report ID:** 18532268
- **Completion Date:** 01/28/2016
- **Expiration Date:** 01/27/2019
- **Minimum Passing:** 80
- **Reported Score*:** 95

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Belmont Report and CITI Course Introduction (ID: 1127)	01/28/16	3/3 (100%)
History and Ethical Principles - SBE (ID: 490)	01/28/16	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	01/28/16	5/5 (100%)
The Federal Regulations - SBE (ID: 502)	01/28/16	5/5 (100%)
Assessing Risk - SBE (ID: 503)	01/28/16	5/5 (100%)
Informed Consent - SBE (ID: 504)	01/28/16	5/5 (100%)
Privacy and Confidentiality - SBE (ID: 505)	01/28/16	5/5 (100%)
Research with Prisoners - SBE (ID: 506)	01/28/16	5/5 (100%)
Research with Children - SBE (ID: 507)	01/28/16	5/5 (100%)
Research in Public Elementary and Secondary Schools - SBE (ID: 508)	01/28/16	5/5 (100%)
International Research - SBE (ID: 509)	01/28/16	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	01/28/16	5/5 (100%)
Research and HIPAA Privacy Protections (ID: 14)	01/28/16	4/5 (80%)
Conflicts of Interest in Research Involving Human Subjects (ID: 488)	01/28/16	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	01/28/16	2/5 (40%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

CITI Program
Email: citisupport@miami.edu
Phone: 305-243-7970
Web: https://www.citiprogram.org

APPROVAL FORM AND ALL ATTACHMENTS MUST BE TYPED!

Bemidji State University/Northwest Technical College
Human Subjects Committee
Human Research Approval Form

Title of Study: Heart Rate and the Face Inversion Effect

Date Submitted: ~~07/31/16~~ 10/25/16   Project starting date: ~~09/01/16~~ 11/1/16   Project ending date: 12/08/16

Principal Investigator(s): Whitney Walker-O'Beirne   BSU Student ID#, if applicable:
11138850

Please indicate if you are: BSU/NTC Faculty   BSU/NTC Student(s) X Non-BSU/NTC

Have all Principal Investigators listed completed the training for Human Subjects research? X Yes   No

Street Address: 9405 Chad Dr NW   Telephone: (218)308-1995

City, State, & Zip Bemidji, MN 56601

E-mail Address: walk1whi@live.bemidjistate.edu

Co-Investigators:

Faculty Advisor/Sponsor: Keith Gora

Request: ☒ Expedited Review (include reasons below)   ☐ Full Review   ☐ Exempt (include reasons below)

The research contains no risks greater than those encountered in daily life.

Is the submitted document in **draft** form yet to be pre-tested?   ☐ Yes   ☒ No
(If Yes, a final copy of the survey instrument must be re-submitted upon completion.)

Can the title of this study be made public before the completion date?   ☒ Yes   ☐ No
Are you using BSU and/or NTC students for this study?   ☒ Yes   ☐ No

The student's faculty advisor must first approve all student research. Signature denotes the advisor's approval of the project and must be obtained prior to forwarding to the HSC in the School of Graduate Studies.

Signature   6-24-2016
Signature of Advisor/Sponsor   Date

For office use only: PH

Has the Advisor/Sponsor completed the training for Human Subjects research? X Yes ___ No

---HUMAN SUBJECTS

COMMITTEE RECOMMENDATION:
_____Exempt Review

_____ Approved   _____ Revise and resubmit   _____ Not approved

Expedited Review

_____ Approved   _____ Revise and resubmit   _____ Not approved

_____ Full Review

_____ Approved   _____ Revise and resubmit   _____ Not approved

2

Appendix C

Table 1.
Effect of Face Orientation and Face Familiarity on Heart Rate Difference Scores

| Learning	Test	Face	M	SD
Upright	Upright	New	-1.785	5.910
Upright	Upright	Old	-1.093	7.559
Upright	Inverted	New	.182	6.941
Upright	Inverted	Old	-1.043	7.077
Inverted	Upright	New	1.580	6.519
Inverted	Upright	Old	.416	6.489
Inverted	Inverted	New	2.078	7.006
Inverted	Inverted	Old	1.640	8.378
Upright	Upright		-1.439	6.397
Inverted	Inverted		1.859	7.530
Upright	Inverted		-.431	6.932
Inverted	Upright		.998	6.340
		Old	.514	6.528
		New	-.020	7.210
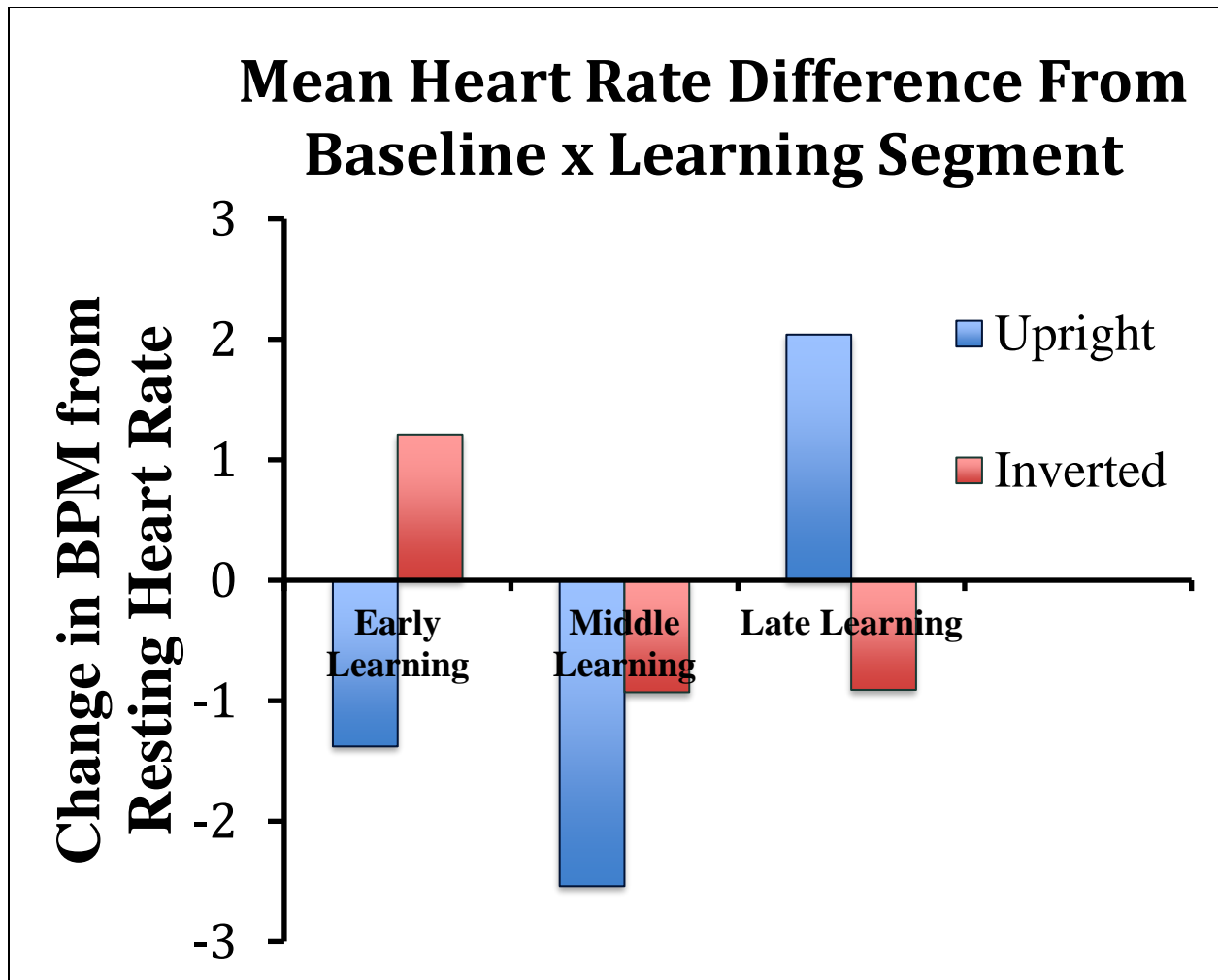
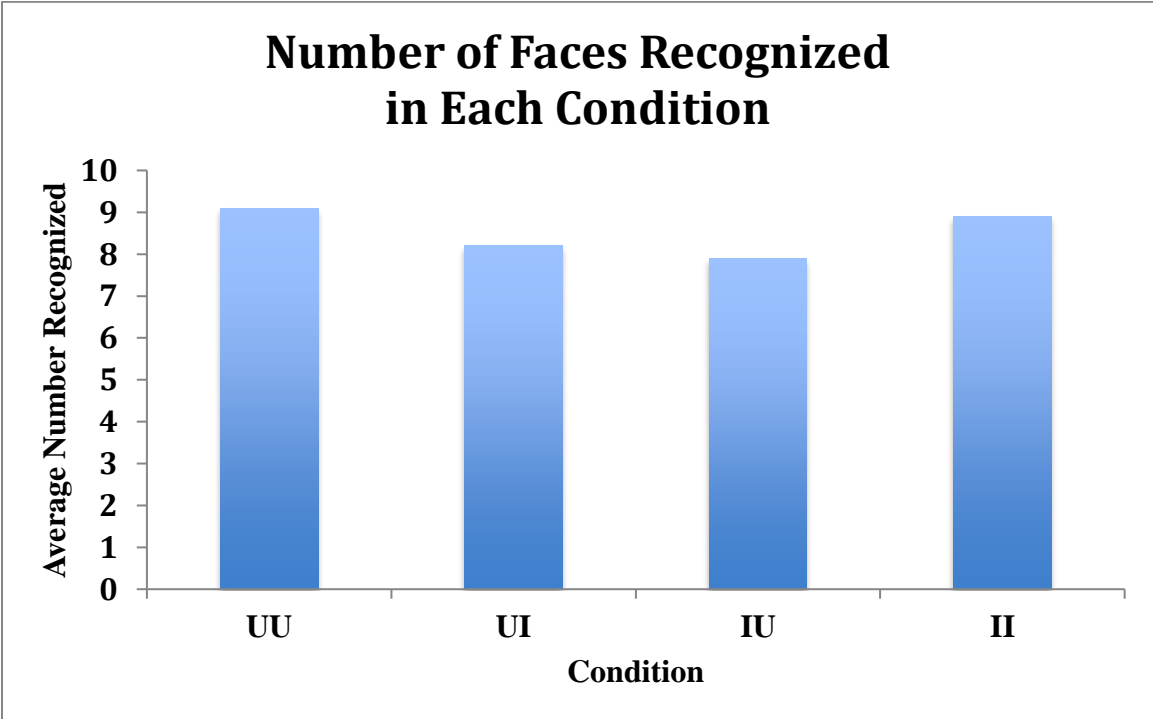*Figure 1.* Mean HR Across Learning Phase Segments

Figure 2. Condition Orientation Across Number Recognized
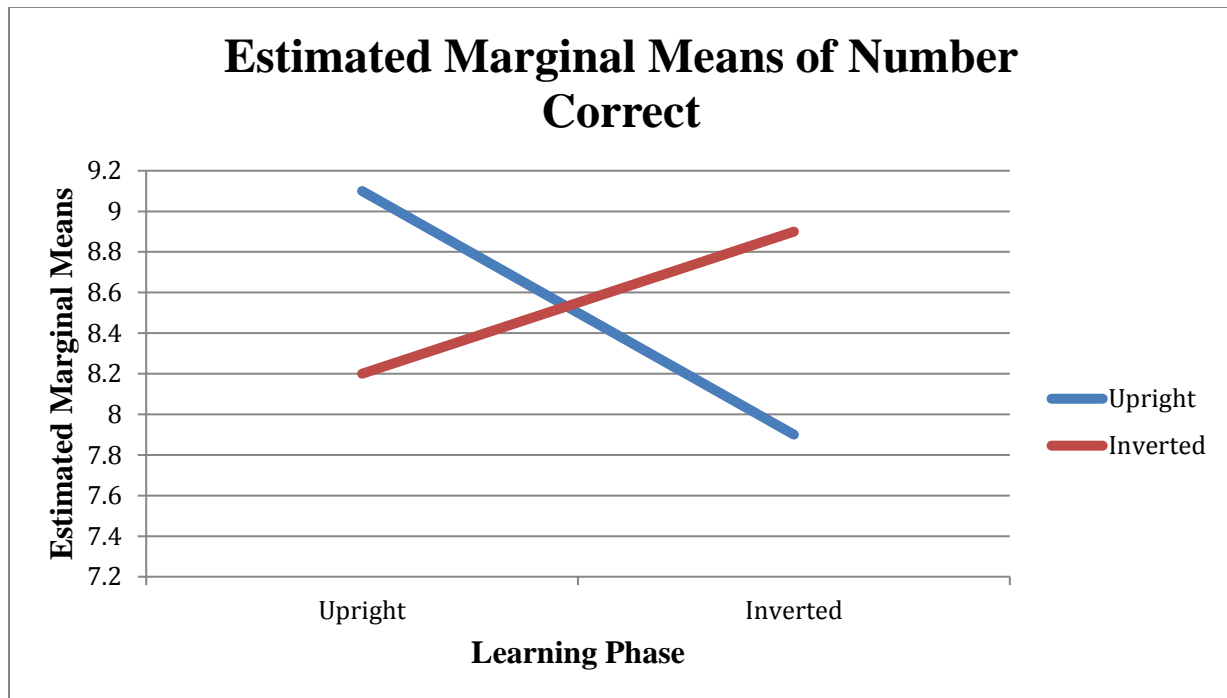
Figure 3. Estimated Marginal Means of Number Correct

Appendix D

Instructions for Participant Before Experiment Begins

Start them in the chairs by the Mac

Introduction:

Thank you for volunteering to participate in our experiment. We are interested to see if we can use heart rate as a measure of face processing ability. In today's study you will complete a face memory task.

You will be presented with a series of images during the learning phase; your job is to try remembering them. After you will be tested with another set of images of which you are to determine if you recall the face or not. Some images may be presented upright or upside down.

Throughout this task, we will also be recording your heart rate using three small sensors. If you consent to participate, one sensor will be applied to each of your ankles and one to your right wrist. Do you agree?

Hand them their paperwork. Consent and Demographic Questionnaire

Consent and Demographic Forms:

Before we begin, you will need to complete some paperwork. The first is a consent form that explains your rights as a participant. It states that you are able to withdraw or quit from the study at any time with no negative consequences. The second asks questions pertaining to your background.

Allow them to complete paperwork. Ask if they have questions. When done escort them to the chair and monitor. Apply the electrodes.

Final Instructions:

Before the experiment begins we will record a two-minute baseline of resting heart rate.

Upon starting the experiment, you will see a black screen with the word ready on it. It is a

signal for you to prepare for the task. It will appear for five seconds.

A blank screen that appears for five seconds will follow. You do not need to do anything but

look at the screen and sit quietly.

Every face will be presented to you for five seconds. Between each image, a blank screen

will appear for five seconds. Remember your task is to try memorizing the 24 faces shown.

Once the learning phase is complete, we will move on to the testing phase.

The testing phase will begin with a black screen that says ready, followed by a blank screen

for five seconds. Ten images will be presented for five seconds with a blank screen in

between each for five seconds. This time your job is to indicate whether you recognize the

image or not.

     If the face is familiar say, "old"

     If the face is unfamiliar say, "new"

After the testing phase is complete, you have finished the experiment and the sensors will

be removed. A debriefing statement will be provided upon completion.

Do you have any questions?

Thank you for your time!