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FACE AND WORD LATERALITY: EXPLORING THE CONNECTIONS

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ABSTRACT

For decades, researchers have demonstrated that the left hemisphere of the brain is lateralized for verbal stimuli processing such as words, whereas the right hemisphere is lateralized for non-verbal stimuli processing such as faces. Researchers used to think that the right hemisphere was relatively inactive and that the left hemisphere did most of the work; however, decades of research and the development of new research techniques have allowed researchers to recognize that both the left and the right hemispheres are very active. Our goal was to expand on the laterality literature, and delve into possible underlying connections for the lateralization effects. In the current study, we not only failed to replicate prior findings, but found an opposite effect.

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I would also like to acknowledge Dr. Donnelly Adams for supplying us with the TOWRE and RAN tasks and giving us instruction on how to use them. As well as Dr. Dundas and Dr. Berhmann who so graciously lent us copies of their original stimuli so that we could attempt to replicate. I really appreciated your openness and kindness during this process.

Introduction

Every day, no matter where we go or what we do, we encounter numerous faces and words. Our brain processes each one as quickly and accurately as possible, deciphering their messages with a unique and stunning accuracy. For example, in less than a minute individuals can accurately predict the end of the year evaluations a teacher will receive through the perception of nonverbal stimuli (Ambady, N., and Rosenthal, R. 1993). Our brains never stop, and work diligently to process the vast information that faces and words present as early as four months old (Farzin, F., Hou, C., and Norcia, A. M. 2012). For many years it was assumed that the processing of words and faces were separate and mutually exclusive from each other. However, research in the past few decades has suggested that there may be a connection between our ability to read and interpret faces and our ability to read and interpret words.

In the first half of the 20th century, it was generally believed that only the left hemisphere of the brain was important in terms cognitive functions and skills. An understanding of the impact and use of the right hemisphere of the brain was not readily noticed until the efforts of Gazzaniga, Bogen, and Sperry in 1962. They were the first in modern science to clarify lateralization effects in split-brain animals and patients. Launching further investigation into the actual use of the right and left hemispheres of the brain.

People began to notice the difference in face and word recognition when patients with lesions and or other brain defects processed faces and words differently. Impairments in the right hemisphere of the brain can lead to facial processing disabilities such as prosopagnosia - a condition where a person has difficultly recognizing or processing faces. As well, impairments in the left hemisphere can lead to speaking and reading difficulties. Paul Broca was the first to realize the connection between brain lesions and verbal stimuli, when he conducted an autopsy on a patient who had speaking difficulties throughout his whole life. Broca provided the first evidence of localized brain functioning, and has influenced the laterality literature profoundly since then (Broca, P. 1988).

Difficulties in the right and left hemispheres were only thought to be independent of each other, and it was assumed that a difficultly in the right or left hemisphere did not negatively impact the functioning of the other. However, a study by Pirozzolo and Rayner (1977) began to explore the possible interconnections of face and word processing. Previous studies had predicted that the processing of words and faces were only partially lateralized, and were actually a multistage process that included the right hemisphere in word processing. They found that word processing, like many other processes, are not solely located in the left hemisphere. In 2012, Berhmann and Plaut discovered that individuals with facial processing difficulties also performed worse in reading tasks. While those with reading impairments did not have a statistically significant difference between their ability to process faces than the control group, this nevertheless put forth additional evidence that facial and word processing may not be mutually exclusive.

In 1985, Saxby and Bryden demonstrated that as early as childhood, individuals have a left hemisphere that appears to specialize in word processing, and a right hemisphere that specializes in facial processing. Later in 1987, William Hahn examined the separation of face and word processing in infants and children. Hahn discovered that language and word processing were clearly lateralized to the left hemisphere, whereas the right hemisphere lateralization was more dependent on sex and developmental differences between children (Hahn, W. K. 1987).

Since then, the field has expanded with the creation of new techniques and new technology, such as fMRI. These new technologies and techniques have allowed researchers to look at where the brain processes information in ways that were not previously possible. These new methods of studying the brain have allowed the literature to expand on Broca's findings, and put forth more evidence demonstrating localization of function in the brain, and brain lateralization.

It has since become an accepted and robust practice to find that the right hemisphere of the brain processes non-verbal stimuli, like facial processing and facial recognition. Whereas, the left hemisphere processes verbal stimuli like language and words. For example, in 2004, Mason and Macrae published a paper on the neural substrates of person perception and categorization. They had participants take an individuation task, and when they analyzed the results based on hemispheric function, the authors found that faces were perceived more accurately in the right hemisphere. As well, when they had a split-brain patient take the individuation and categorization task, they found that the participant was more accurate at individuating faces when they were presented to the left visual field, which were then processed in the right hemisphere. Their third study used fMRI technology to see that the areas like the right fusiform gyrus, and right inferior temporal gyrus were used during the individuation task. Their findings added to the previous literature, strongly suggesting that facial processing was lateralized to the right hemisphere.

In addition to Mason and Macrae, a study by Funnell, Corballis, and Gazzaniga (2001) used a different split-brain patient to demonstrate that not only were faces lateralized to the right hemisphere, but objects could be as well. Images of objects are generally bilateral, however in the split-brain patient the right hemisphere took up the visual stimuli, whereas the left hemisphere mainly processed verbal stimuli. Earlier data combined with new studies like that of Mason and Macrae (2004), and Funnell, Corballis, and Gazzaniga (2001), demonstrate that our brain sections off verbal and non-verbal processes to different hemispheres emphasizing a solid and robust foundation for lateralization.

What is more, these effects persisted regardless of priming. In 1976, Klein, Moscovitch, and Vigna ran studies looking at how priming may impact the lateralization process of verbal and non-verbal stimuli. Despite hemispheric priming, participants still performed better in the left visual field for faces, and the right visual field for words. They even saw an increase in accuracy in the non-primed visual field. To the researchers, this demonstrated that there were underlying mechanisms that could influence lateralization (Klein, D., Moscovitch, M., & Vigna, C. 1976).

In 2013, Dundas expanded upon their previous findings from 2012 in order to better understand how lateralization occurred with faces and words through the years (Dundas, E. M., Plaut, D. C., and Berhmann M. 2013). Their study had two goals; to evaluate the developmental emergence of lateralization, and to examine the relationship between face and word processing. They found that adults had clearly distinguishable lateralization, however adolescents and children were mostly lateralized in word processing, with insignificant results in a hemispheric preference for facial processing. This led the authors to believe that it was the acquisition of reading and word processing, a cognitively intense process, which lateralized the brain. The idea is that from the time that people are four months old they begin to process faces and non-verbal stimuli. During that time, before infants begin to process words, both hemispheres may be used to process faces. However, when infants begin to process verbal and written stimuli, in order to more effectively store and process information, it is believed that the brain lateralizes the processes to different hemispheres.

Dehaena, S., et al. (2010) noted that in many studies evaluating reading and facial processing they are usually conducted on college age students or older, individuals who by most standards already have a well developed reading ability. Dehaena felt that by testing individuals in the population that already had well developed reading ability that it would possibly confound results and miss information about how face and word processing mold our neural networks. Dehaena and colleagues, were thus more interested in seeing how literacy throughout the ages influenced the neural networks in the brain. What the authors found was that learning to read, at any age, enhanced brain functioning and responses. Learning to read enhanced the brain by boosting organization of visual cortices, by allowing the language network to be activated and practiced by the written word, and by refining the language acquisition process. However, they also found that face perception abilities suffered in proportion to reading skills. Both improved, but word processing had a greater improvement. Their findings add to the notion that learning to read alters brain organization, and potentially lateralizes brain functioning, while also improving face and word processing.

Additional evidence was also put forth in 1998 by Kelley and colleagues, that word and face processing may not be mutually exclusive. Kelley et al. found that the nature of the material being encoded mattered, and that depending on the material, it would be encoded differently. These findings further demonstrated that there was not a mutually exclusive nature to the processing and encoding of faces and words.

Having an understanding of the depth at which the literature demonstrates the lateralization as a robust and commonly understood finding, we wanted to look more closely into the underlying connections that these processes could have. We were interested in seeing how handedness played a factor in brain lateralization, because left-handed individuals tend to have a different brain organization the right handed individuals. Thus, we included a handedness measure in our demographics section. As well, we were hoping to see if handedness could have a possible connection with visual impairments such as those with dyslexia and prosopagnosia. We designed our experiment initially to replicate and extend Dundas, Plaut, and Berhmann's laterality tasks in 2013 with the ultimate hope of looking into greater underlying connections and causes.

We expected to find that the left visual field would be faster and more accurate for facial processing, and that the right visual field would be more accurate and faster for word processing. In addition to the laterality tasks, we administered other tests to determine accuracy and ability in face and word processing. The tests we utilized for word processing were the Test of Word Reading Efficiency (TOWRE) and a short version of the Rapid Automatized Naming (RAN) test (Torgeson, Wagner, & Rashotte, 1999). The method we used for testing face processing and ability was the Cambridge Face Memory Test (CFMT). We also used the Diagnostic Analysis of Nonverbal Accuracy (DANVA) to assess a relationship between verbal and nonverbal facial processing (Franklin & Adams, 2010; Palermo et al., 2013). We speculated that the better and individual was at reading, the better they would be at the face memory and processing tests. We are still coding these tests for use in future analyses. I describe them below, but do not include analyses in the context of this thesis work.

Methods

Participants

All of the individuals used in the following studies were undergraduate students at the Pennsylvania State University, who were taking introductory psychology courses and received class credit or extra credit for their participation.

In Study 1, we had an *N* or sample size of 31 students. Only four of which were male, and the other 27 were female. The average age was 18.86. As well, four of them were left handed, the rest were right handed. In Study 2, our second attempt at finding the robust laterality effects, the sample size was 73, with 16 male participants and 57 female participants. We had more women than men participate in the study, which may have impacted the results. The average age was 19, and the majority of participants were right handed with only five individuals showing a preference for left-handedness. A comparison of the demographics for Study 1 and 2 are in *Table*

Table 1 Demographics Comparison

Demographics	*N*	Mean Age	Right	Left	Female
Study 1	31	18.86	27	4	27
Study 2	73	19	68	5	57

Materials

In Study 1, our first replication attempt, we followed the actions taken by Dundas, Plaut, and Berhmann (2013), as outlined in their 2013 study. The stimuli were made of faces, cars, and words, all of which were the same exact stimuli from the 2013 Dundas, Plaut, and Berhmann study, obtained from Dr. Berhmann. The stimuli were comprised of thirty male and thirty female faces, all of which had been cropped to have the hair removed. As well, all faces faced forward, and had a neutral expression. The face images were originally taken from the Face-Place Database Project (Dundas. 2013). As well, there were sixty words that made thirty pairs, and sixty car images that also created thirty pairs. All of the words were real words and four letters long. The pairs of faces always had the same gender, while the words would either be the same or would differ by one of the interior letters. For example, the one word would be “bend” and the other could be “bend” or “bead”. The cars served as a control group, and all images were presented in greyscale. The words were presented in 18-point font, in grey, against a black background. The car and face images were 1.5 inches in height and 1 inch in width, also put against a black background.

We included additional measures after the laterality task in Study 1 and Study 2 to examine other possible connections between face and word processing. We included the Cambridge Face Memory Test (CFMT), the DANVA, the TOWRE, and the RAN. The CFMT and the DANVA were assessed on a computer, alongside the laterality test, whereas the TOWRE and the RAN were assessed in a separate room by an experimenter. As well, a question related to their handedness and other basic demographic features were added to the end of the computer segment.

In Study 2, we attempted to find laterality by replicating Mason and Macrae’s study from 2004 that was mentioned earlier. For this experiment we used facial stimuli from the Dundas, Plaut, and Berhmann 2013 study, which we had used in the previous replication attempt. We also used three letter words as the verbal stimuli, the words were used from a prior lab study where another researcher had tried replicating Mason and Macrae in the past. There were two blocks to the laterality task. Faces were the first, and words were the second. In the laterality task two words/faces would be presented in either the left or right visual field. The two stimuli would be vertical, one “on top” of the other. There were two types of trials within each block – matching and non-matching. In the matching trial the two stimuli (words or faces) would be the same. In the non-matching the two faces or words would be different. The faces and words were presented ten degrees above and to the side of a center fixation cross.

The Rapid Automized Naming (RAN) test measures how fast a participant can process and name a word. This was one way in which we were trying to examine a person’s word processing ability. There are different test sections to the RAN, however we only used test 4 (Denckla and Rudel,1976). This test has been used in many different ways to assess verbal processing and reading ability, such as in 2014, when Horowitz-Kraus and colleagues used it to evaluate children’s reading comprehension before and after language intensive training. With the RAN as one of the bases for evaluating word processing the authors were able to demonstrate that accelerated reading programs may benefit many children, regardless of language, in their word processing and reading comprehension (Horowitz-Kraus, T., Cicchino, N., Amiel, M., Holland, S. K., & Breznitz, Z. 2014).

The Test of Word Reading and Efficiency (TOWRE) was also used to assess an individual’s reading capability and processing ability. This test is normally used to look for possible dyslexia in individuals, however we used it as a measure of word processing ability, just as Kuhn, et al. did in 2006. In 2006, Kuhn and colleagues were testing out different teaching techniques to evaluate how it impacted children’s reading fluency. It was one of a few different tests that were administered to the children to assess their word processing and reading ability before and after the teachers underwent professional development based on the concepts Kuhn and colleagues proposed (Kuhn et al. 2006). We used both parts of the TOWRE and had participants read real words and pseudo words aloud (Torgeson, Wagner, & Rashotte, 1999).

The Cambridge Face Memory Test (CFMT) measures the ability of an individual to process and recognize/identify faces. The CFMT is often used in assessing and understanding those who have facial recognition and processing difficulties, like those with autism. An example of this was in 2011 when Hedley, Brewer, and Young used the CFMT to analyze and test participants with Asperger syndrome when comparing autistic individuals with their control counterparts who did not have autism. From this study they were able to conclude that autism and face processing is on a continuum, and is not always severely impaired for autistic individuals (Hedley, D., Brewer, N. and Young, R. 2011). The CFMT is made up of 72 items, and we used it to assess how well a participant could process faces (Duchaine and Nakayama, 2006).

The Diagnostic Analysis of Nonverbal Accuracy (DANVA) measures a participants' differences in being able to send and receive nonverbal social information – things like facial expressions. It is made up of 24 adult faces, both male and female, expressing either happiness, anger, fear, or sadness. This assessment is usually used to evaluate facial processing in the form of facial expressions. Many times throughout the literature researchers have used it as a standard method of assessing a person's ability to process social stimuli. As well, in 2010 Franklin and Adams demonstrated that the DANVA tends to correlate with face memory – an aspect of facial processing. We used it to measure a participant's ability to accurately process facial information (Duke and Nowicki, 1994).

Procedure and Design

Study 1 and Study 2 had identical operational procedures. They were conducted in two rooms. Four participants at a time would first enter a room with six computers, each taking a seat at one of the end computers, leaving the middle computers empty and space between each participant. This was not so much by design as it was just something that we found comfortable. The programs were staggered, allowing for one participant at a time to be taken to the second room to take the TOWRE and the RAN. When the participant finished in the TOWRE and RAN, then they would either return to finish the computer tasks, or leave once they were finished. In the second room, the participant would take a seat across a table from one of the researchers. The researcher would have a stopwatch, and a laptop to record the responses to the TOWRE and RAN. After the TOWRE and RAN were completed, each participant would return to the first room and complete the remainder of the study on the computer. The study would be completed by each participant in an hour allotted time slot.

On the computer, each participant would take the laterality task that was a replication of Dundas' study in 2013 for Study 1 or Mason's study in 2004 for Study 2, then the CFMT, the DANVA, and lastly a demographics survey. It was staggered as such; one participant would finish the laterality task, and then be brought over to the second room for the TOWRE and RAN. After the first participant was finished with the TOWRE and RAN, they would return to the first room to complete the CFMT and the DANVA. The computer notified the participants when to get one of the experimenters, who would then proceed with the TOWRE and RAN. When the second participant finished the laterality task and the CFMT, they would receive a notification to get a researcher, and it continued to stagger as such for each participant. Each participant took all parts of the experiment, just at different times throughout the allotted hour.

For Study 2 we also ran a power analysis to gauge how many participants would be necessary beforehand, with the hopes of finding statistically significant results. The power analysis revealed that at least 64 participants were needed for our study. A power analysis was not conducted for Study 1.

Results

We started by analyzing the data with basic descriptive statistics in order to get a feel for what it looked like. In each study we looked at the mean, median, mode, and calculated for outliers. For each study, we examined accuracy and reaction times for face left and right processing, as well as word left and right processing. We also performed paired sample t-tests, on all of the results to assess possible statistical significance in the results. All analyses were completed on only correct trials for both studies. Before completing the second study, a power analysis was conducted on previous lab research, similar to the current study, to analyze how many participants were needed for a moderate effect size. The power analysis revealed that at least 64 participants were required.

In Study 1 we failed to replicate previous findings. In the Dundas, Plaut, and Berhmann study they used 24 participants and we had 31. We felt that 31 would have been an adequate number to see significant results. However, neither the face accuracy, word accuracy, face reaction times, nor word reaction times were statistically significant in our study. Although, the faces were perceived more accurately and more quickly in the left visual field. This finding was not significant. Facial accuracy, $F\ (1,30) = 2.060$, $p = 0.162$; face reaction times, $F\ (1,30) = 1.260$, $p = 0.27$. The words were also not statically significant, however participants were more accurate in the right visual field, and faster in the left visual field. Word accuracy, $F\ (1,30) = 4.032$, $p = 0.054$; word reaction times, $F\ (1,30) = 0.726$, $p = 0.401$. These results are shown in *Figure 1.* and *Figure 2.* Because the results were insignificant, and the words showed a minor flip in reaction times, we decided to test a different laterality task to find the robust laterality effects.

Figure 1 The average accuracy across trials for face and word processing in the left and right visual fields

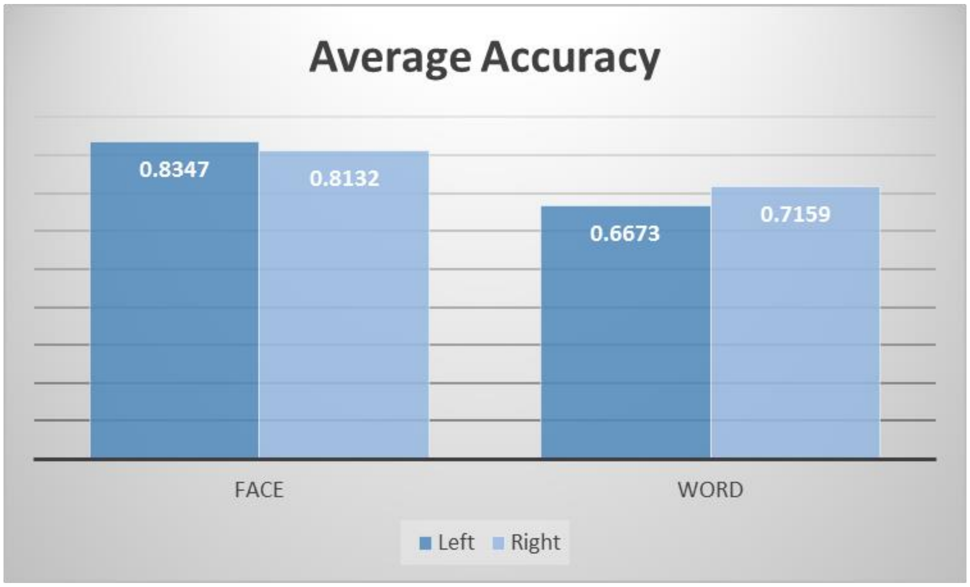

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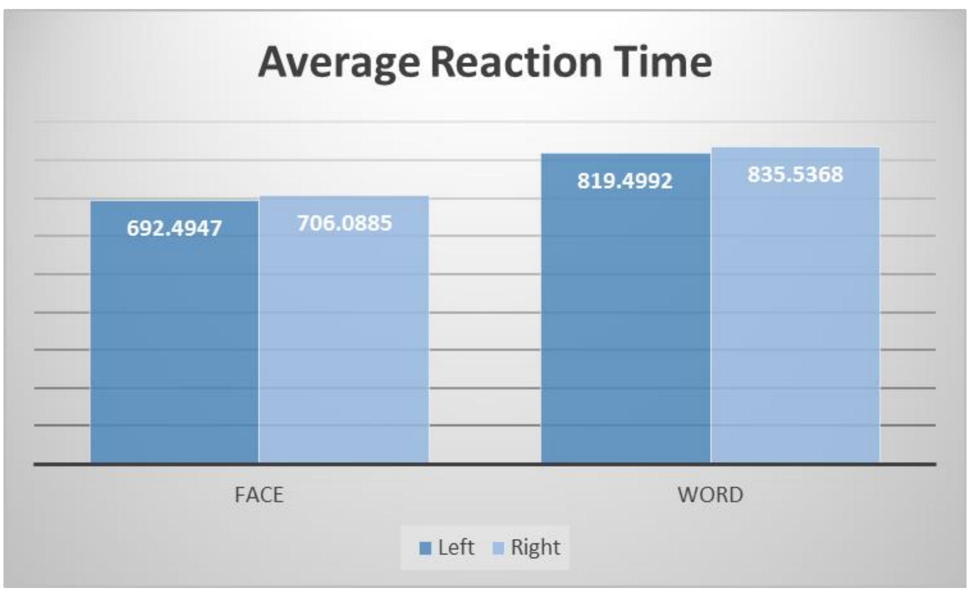
Figure 2 The average reaction times across trials for face and word processing in the left and right visual fields. The times are presented milliseconds



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Before conducting Study 2, we ran a power analysis based on prior lab attempts at replicating lateralization. We wanted to get significant results so that we could build off them. The power analysis revealed that 64 participants were needed to find strong effects.

Study 2 had an interesting result that was unexpected. The results showed the exact opposite trend of what is typically found from the laterality tests. In our case, the right visual field (leading to the left hemisphere) was more accurate for face processing, and the left visual field (leading to the right hemisphere) was more accurate and was also faster for word processing. However, only the results for the word accuracy and word reaction times were statistically significant. Our analysis revealed that people performed better on word accuracy than on face accuracy. F (1,55) = 184.603, $p < 0.001$. However, there was no significant difference between face and word reaction times. F (1,55) = 1.010, $p = 0.319$.

For words, the left visual field was more accurate than the right visual field. F (1,55) = 22.054, $p < 0.001$. The left visual field on average was accurate 82.65% of the time, whereas the right visual field was correct on average 78.57% of the time. The difference between the left and right visual fields were significant for words. F (1,55) = 22.054, $p < 0.001$. The difference in reaction times for words were not significant, however the right visual field for words was faster. F (1,55) = 2.372, $p = 1.29$. The results for reaction time differences for face and words trials are shown in *Figure 3*.The difference between the left and right visual fields and face accuracy were insignificant, F (1.55) = 0.915, $p = 0.343$, as were the difference between visual fields and face reaction times. F (1,55) = 0.628, $p = 0.431$. On average the left visual field for faces was accurate 62.53% of the time, whereas the right visual field was correct on average 63.54% of the time. The differences, however are insignificant. The results for the average accuracy between words and faces, as well as visual fields are shown in *Figure 4.*

Figure 3 The average reaction times across trials for face and word processing in the left and right visual fields. The times are presented in milliseconds

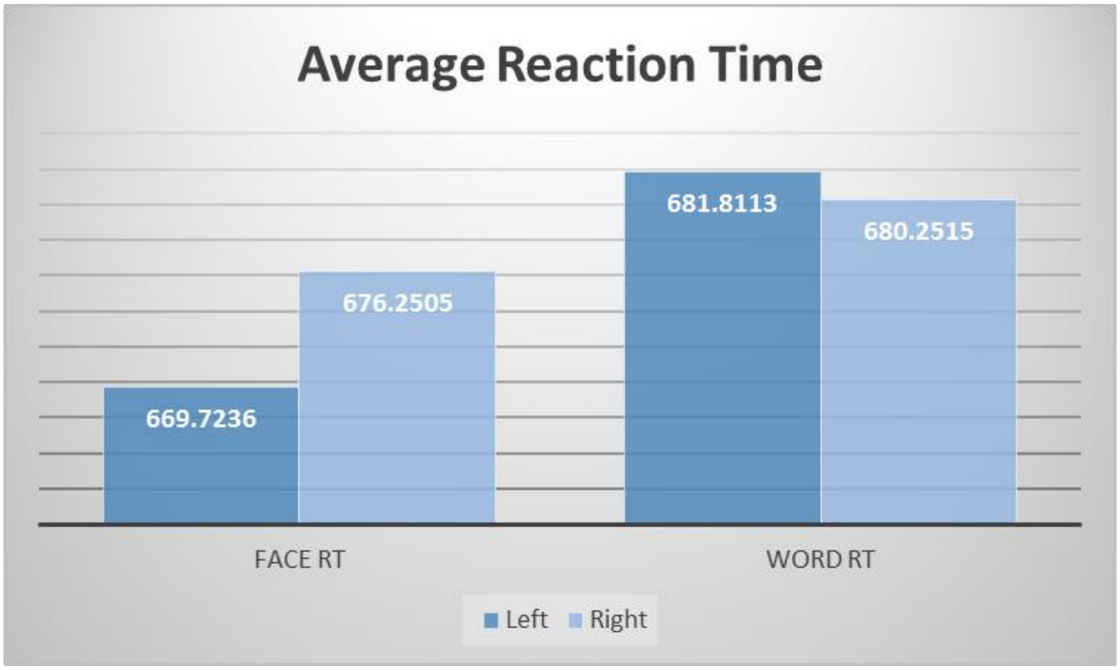

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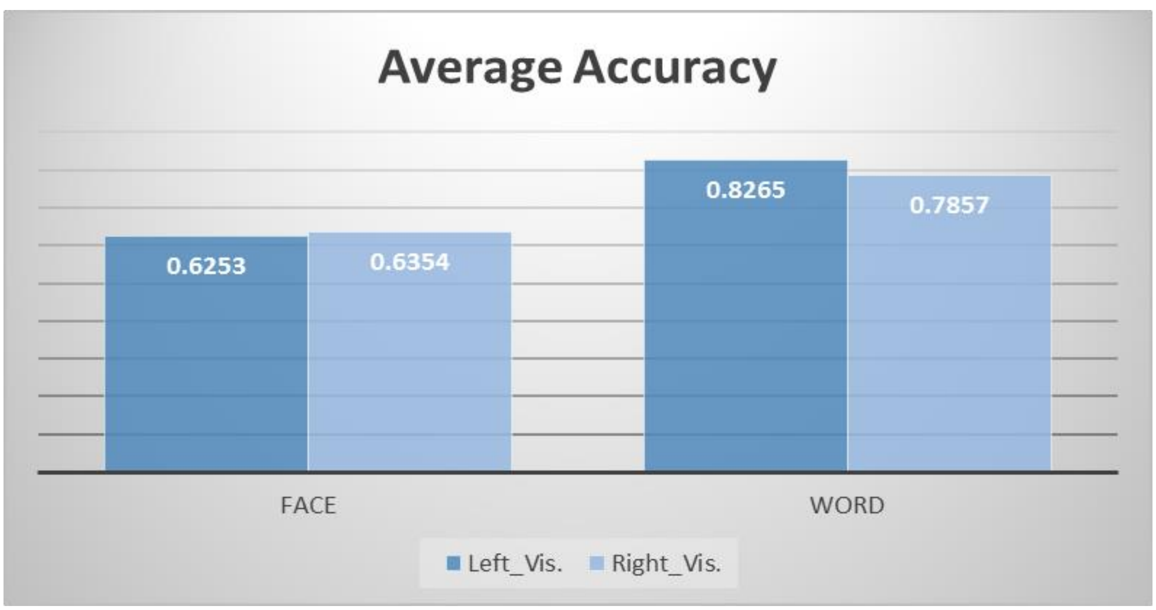
Figure 4 The average accuracy across trials for face and word processing in the left and right visual fields



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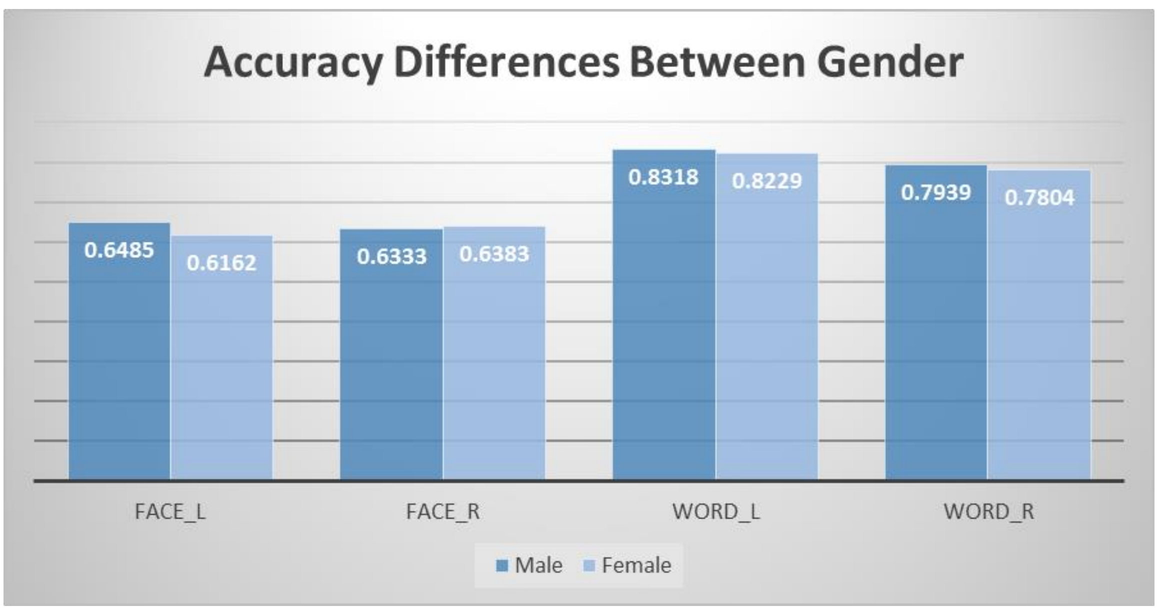
After discovering that the results were so different from what the previous literature has shown, we decided to examine possible gender differences. We did so, because the participants were mostly female and previous studies have shown that females tend to be less lateralized than males. We found that the gender differences in responses were not significant between accuracies for words. *P* = 0.844, or faces, *p* = 0.159, as depicted in *Figure 5*. We also examined handedness to see if that may have impacted the results. While there were significantly more right handed individuals (only 5 people were considered left handed), the differences between left and right participants' responses were not statistically significant. *F* (1,54) = 0.306, *p* = 0.583. Neither handedness nor gender seemed to be driving the odd effect.

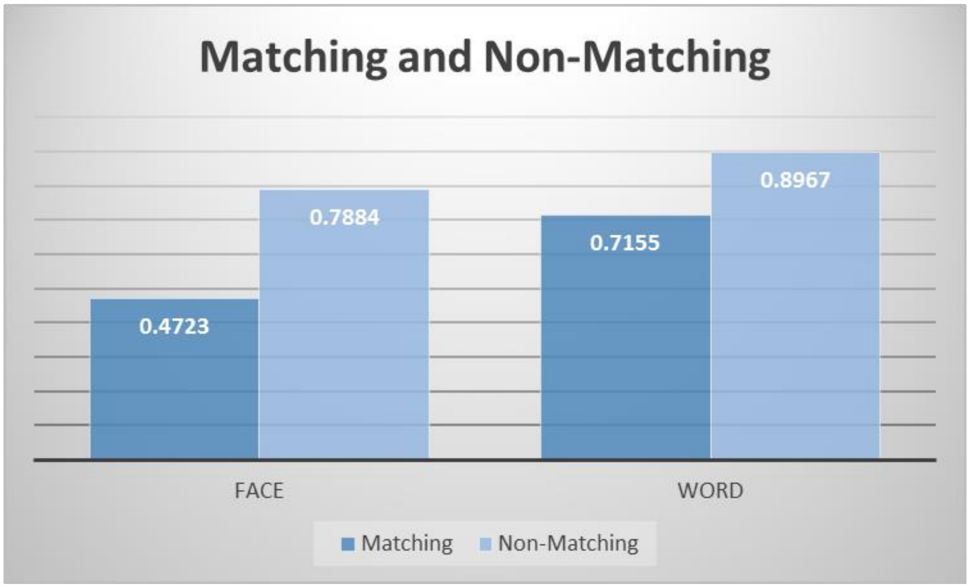
Figure 5 The word and face processing differences in accuracy between male and female participants



After realizing that gender and handedness were not driving the odd flip effect where words were more accurate and faster in the left visual field and faces were more accurate in the right visual field, we went back to re-evaluate the laterality program itself. Given that the results were the opposite of what we were expecting to find, and that this effect is a robust one that has been replicated several times over the past half century, we felt it was necessary to re-evaluate the laterality program. We looked through the coding, syntax, and stimuli of the laterality program to see if any errors had occurred. After checking all parts of the laterality program, it was concluded that all of the data had been entered in correctly, and that these effects were not a result of a programming error.

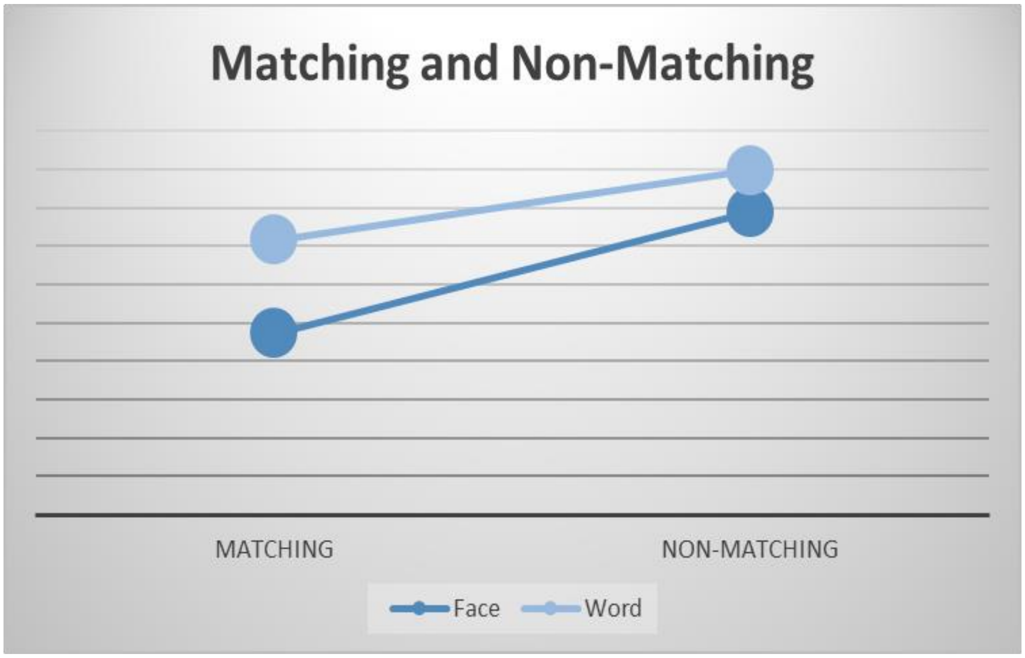
Once we determined that the results were not due to a programming mistake, we began to look at how the participants did during the matching and non-matching trials. In the laterality test participants pressed the up key if they thought that the two faces or words presented were the same/matching, or down if they thought that they were different/non-matching. What we found after running t-tests, was somewhat similar to the previous t-test analyses. The differences between the two visual fields were significant for the word accuracy trial just as we had seen earlier. Accuracy, F (1,55) = 22.054, $p < 0.001$; reaction time, F (1,55) = 2.372, $p = 1.29$. Although, what was really interesting, and unexpected, was that the accuracies for the matching and non-matching face trials were starkly – and statistically - different. Participants performed below chance level on the matching trial, and above chance on the non-matching trial. F (1,55) = 74.074, $p < 0.001$. People did not perform below chance on the word accuracy trial, but they did do significantly better on the non-matching word trial, than on the matching trials. F (1,55) = 57.928, $p < 0.001$. These results are shown in *Figure 6.*

Figure 6 The differences in Matching and Non-Matching face and word accuracy trials. Both of which are statistically significant



In addition to the statistical difference between face/word matching and non-matching trails, there was also an interaction between type (face and word) and "matchingness" (matching and non-matching. This interaction is shown in *Figure 7*. F (1,55) = 14.135, $p < 0.001$.

Figure 7 A statistically significant interaction between matching and non-matching trials, and face and word trials



We were hoping to correlate and review the additional tasks to see how those related, however do to a program failure and human error we were unable to get accurate and reliable statistical information for the correlations. Due to the unique and odd results of our replication attempt we were not able to delve into further experimental procedures that could have expanded on possible connections between face and word processing. Without our ability to replicate the previous effects, we were unable to test the underlying mechanisms that may be connected to the effects that other researchers have found.

Discussion

The results of Study 2 were very surprising and left us with many questions. Despite our exhaustive attempts, we are not sure why the results of our study failed to replicate an immensely robust and common effect. One idea that we originally had was that the ratio of women to men in the study may have influenced the results. It has been found in previous literature that women are less lateralized than men are, hence this may have impacted our results when we were looking at laterality. However, as our analyses demonstrated, it did not appear that gender was a mitigating effect. Human error may also have come into play in this situation. Including myself, there were several other people who were helping me run participants, and between the different people instructions and procedures may have been altered without us being aware of it. We feel as though human error was the cause of many of the problems with the correlational data that we are unable to report. At the end of the day however, we are just really unsure as to why the laterality results came out as they did.

This is a very perplexing finding, especially given the wealth of information that is available on the topic. Our results could be spurious and or random, and not have any implications or substantial meaning in the realm of social psychology. However, it may also be possible that our minds may be altering to a new landscape and what researchers have found in the past may no longer apply. However, that explanation is highly unlikely. Our lab has conducted laterality tests like these in previous years and arrived at the desired outcome, leaving us with a lot of unanswered questions. Is it the researchers who are influencing the results? Or is the Penn State student population changing? If so, what and how?

These are hard questions for our lab to answer. It has frustrated and boggled us that our attempt failed to find a robust effect, as well as the fact that we arrived at the opposite results intended. In order for these results to call into question other research findings however, we would have to replicate our findings several times over. Thus, while it is strange that we have not found the intended results, it is too soon to say if our findings mean anything or are just a fluke.

The most interesting, and novel find, however, was that despite having no statistically significant main effects, the difference between the matching and non-matching trial of face accuracies was statically significant, and below chance for the matching trial. Other researchers in this field have not separated the trails out to contrast effects between the matching and non-matching trials. What this could mean is that the matching face trails were too difficult for the participants, but that the similarly structured non-matching ones were not. In addition to the statistical significance and massive difference between the matching and non-matching trials, there was an interaction between type and “matchingness”. Both of these findings really intrigued us, because we based our laterality task off of Mason and Macrae, who successfully found the laterality effects we were looking for, but did not dissect the trials and compare matching and non-matching trials. Sense it does not appear that other researchers have examined trails based on matching and non-matching results, this appears to be a novel finding. It makes us wonder how profound this effect really is, and if it has just gone unnoticed for years. It would have been even more interesting to find the difference in matching and non-matching had we been able to replicate previous findings.

It was disappointing to have not been able to replicate Study 1, especially given that in the Dundas, Plaut, and Berhmann (2013) study they used 24 participants to achieve their results and we had 31 participants. All in all however, our results do not contribute much to the field, but do leave a lot of unanswered questions as to how and why the results were so different from what the field has found for decades. It is possible that this is a random event and not replicable, however if it is replicable it could call into question decades of research. The most interesting find, to us, however was the huge difference between face matching and non-matching trials, and the interaction between type and "matchingness". To further examine these results more laterality data analyses are needed to separate matching and non-matching trials, and more replications will need to be attempted. Doing so would give the field an idea of how profound this result is, and if it means anything outside our study.

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ACADEMIC VITA

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Education

The Pennsylvania State University, University Park, PA **5/2015**
Bachelor of Arts in Political Science and Psychology
Minor in Communication Arts and Sciences
The College of Liberal Arts & Schreyer Honors College Thesis Pending
Paterno Fellow: innovative honors program

Leadership Experience

Resident Assistant, South Halls Resident Life, Penn State **8/2013 - Present**
- Create, plan, and host educational and community oriented events several times a month to build a fun and educational community within the residence halls.
- Establish a safe and fair living environment through the enforcement of university policies.
- Act as a university resource and leader to the 60 students on my floor by assisting with problems and providing options for resolutions.

Research Assistant, Psychology Dept., Penn State **2/2013 - Present**
- Create and run social psychological studies that assist Penn State graduate students with their research on social vision and interpersonal perception phenomena through literature reviews, stimulus production, and operating the actual studies.
- Conduct personal research as well as manage students who act as the participants in the various psychological studies every semester.

Teaching Assistant, Communication Arts and Science Dept., Penn State **1/2014 - 5/2014**
- Acted as a resource and guide for 22 students for the spring class of Persuasive Speaking.
- Led review sessions and conducted class in the professor’s absence.

ITS Lab Consultant, Penn State **1/2014 - Present**
- Enhance Penn State’s computer lab experience by providing direct and constant assistance over general questions and special multi-media equipment.
- Oversee the various computer labs throughout campus, making sure everything is fully functional.

Activities

Phi Sigma Pi National Honor Fraternity, Penn State **9/2013 - Present**
- Work with fellow members to orchestrate scholarship, fellowship, and leadership events that embody the values of the fraternity pertaining to the advancement of academic, professional, and social ideals.

Phi Alpha Delta Pre-Law Fraternity, Penn State **2/2013 - Present**
- Explore the realm of law and learn about what we can offer the legal field, and what it can offer us.
- Collaborate with other fraternity members to facilitate events in the name of service and professionalism.

Penn State IFC/Panhellenic Dance MaraTHON, Penn State **9/2012 - Present**
- Facilitate the operation and success of the largest student run philanthropy in the world with over 15,000 other students participating annually.
- Coordinate with 45 other student volunteers on my committee for a yearlong preparation of a 46-hour event that raised over 13$ Million last year alone.

Awards

Thomas D. Fulton Scholarship recipient since freshmen year.

Dean’s list every Semester & Merit based scholarship recipient	Whitmer, Croteau Trustee, and Miller Bruce scholarships.