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Predictions of Performance by EEG and Skin Conductance

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Abstract

The present study analyzed the predictive power of lateralized cortico-electrical patterns (measured by EEG) and arousal (measured by Galvanic Skin Conductance) on performance during a visuo-spatial, motor-response task. The task was a videogame specifically designed to induce flow based on the criteria for flow state established by Csikszentmihalyi (1999). Specifically, alpha activity (8-12Hz) and delta activity (1-4Hz) in the temporal lobes, and skin conductance were examined as predictors of improved performance on the videogame. A regression analysis of the data found that greater left temporal alpha activity, compared to that of the right temporal lobe, was a positive predictor of performance. No significant results were found regarding delta activity, however skin conductance was found to positively correlate with performance. Surprisingly, theta activity (4-8Hz) and mid beta activity (16-20Hz) were also found to have a main effect on performance.

1. Introduction

Performance on motor tasks varies greatly depending on the mental state of the participant. Sports psychology has ascertained for decades that mental states can lead to improved performance, but several other areas of human performance such as music and problem solving have also shown optimal psychological states for participants (Legrand and LeScanff, 2003; Strack, 2003; Kraus, 2003; Lindsey, 2005; Csikszentmihalyi, Abuhamdeh & Nakamura, 2005). Of particular interest is the state of "flow", a state of complete absorption in an activity focusing solely on the pleasure of the challenge at hand and ignoring fatigue, time, and difficulty. Measures of flow generally depend on subjective ratings such as the Jackson and Marsh Flow Sate Scale or online ratings during pauses in performance (Jackson and Marsh, 1996; Kraus, 2003). However, little is known about the neurological correlates for state of flow. Electroencephalography (EEG) research on performance indicates that high performance on motor tasks relates to high Alpha (8-12Hz) frequencies; however no study has examined the EEG patterns of performance on a flow state-inducing task. In the present study, participants will engage in a simple motor response task designed to highlight the features of flow in an attempt to locate electroencephalography (EEG) patterns correlated with high performance.

Several studies have associated the subjective state of flow with high performance, ranging from archers to musicians (Kraus, 2003; Lindsay, Maynard & Thomas, 2005; Csikszentmihalyi et al., 2005). Despite the focus on professionals and experts, flow is an experience anyone can feel during a deeply enjoyable, challenging activity (Csikszentmihalyi, 1999). Csikszentmihalyi (1999) wrote, "It [flow] is reported by teenagers

who love studying, by workers who like their jobs, by drivers who enjoy driving". Activities such as reading a good book, completing a crossword, or finishing a writing assignment can induce high levels of absorption associated with flow. Commonly, flow state is measured through questionnaires regarding postmortem analysis of performance. Jackson and Marsh designed the Flow State Scale in 1996, which assesses flow on a scale of 9 factors with 36 total items (Jackson and Marsh, 1996). The factors were derived from the work of Csikszentmihalyi (1990) and include: challenge-skill balance, action awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, transformation of time, and an autotelic experience. Other studies have employed similar questionnaires or measures of flow based on subjective self-assessment (Jackson and Eklund, 2002). Overall, three key criteria are generally accepted as necessary to induce the flow state: clear goals, online feedback and an acceptable level of difficulty. Certain lines of research indicate that the flow experience is a rare one and involves skill and perseverance (Csikszentmihalyi, Abuhamdeh, & Nakamura 2005), still some form of flow state may be present whenever enjoyable absorption occurs.

This study is designed to make use of the often-addictive nature of videogames with the intention of inducing flow. By employing an engaging and enjoyable videogame that requires constant attention, participants should experience some form of flow. However, instead of analyzing flow states through self-reports and subjective measures, this study will make use of the concept of flow to evaluate performance. Utilizing Csikszentmihalyi's (1999) criteria of flow, this videogame was designed to highlight these features. The videogame is a simple driving game in which a vehicle travels down a winding road and must not crash into the walls of the road. Keeping the three criteria in mind: clear goals, online feedback, and appropriate balance of challenge and skill. First, as a participant, achieving a higher score than that of previous trials becomes the long-term goal. By design, the goals are very clear; last as long as possible without crashing. Second, online feedback is accomplished very clearly through the direct responsiveness of the game. One button press corresponds to one movement and all crashes are the result of a mistimed movement. For the last criteria, balance of challenge and skill, a person's ability must be adequately challenged without causing excessive frustration. If the challenge is too easy, the participant becomes bored and if the challenge is too difficult, frustration sets in (Csikszentmihalyi, 1999). By keeping participants informed of their personal high-score, the challenge of the game is relative to the participant's own skill. Participants compete against themselves thereby keeping the balance of challenge and skill reasonable. Ideally, by highlighting these criteria for flow, participants will reach states of flow during trials of high-performance on the videogame.

Due to the fast-paced, fluid nature of the videogame, testing participants' flow while playing was not feasible. However, the level of flow is not of interest in this study, but rather the neurological correlates to high-performance. The criteria for flow have been employed in the design of this game in an effort to maximize flow; however subjects are being tested for peak performance, not flow. Prior research indicates that increased mean alpha power prior to a visuo-spatial task leads to better performance (Kerick, Douglass, Hatfield 2004; Landers et al. 1994; Hatfield et al. 1984). In particular, studies on novice pistol shooters, archers, and riflemen indicate that a hemispheric difference in mean alpha power correlates to improvement on the task. Specifically, increased alpha in the left temporal region and no change, or reduced alpha power in the right temporal region led to an improvement in performance (Kerick, Douglass & Hatfield, 2004; Landers et al., 1994; Hatfield et al., 1984).

The most common hypothesis suggests that this decrease in left temporal activity indicates a reduction in internal verbalizations allowing the visuo-spatial right brain greater dominance, "This increase in EEG activity within the alpha frequency range has been interpreted as representing a reduction of cortical activation in the left-temporal region, reducing the covert verbalisations of the left-brain and allowing the visual-spatial processes of the right hemisphere to become more dominant" (Vernon, 2005). The present study examined the relationship between hemispheric differences of mean alpha power and performance using EEG recording. Increased mean alpha power in the left temporal lobe prior to game play (Prior Condition) was predicted to correlate with better performance as indicated by a longer trial on the videogame. For the right temporal lobe, no significant results were expected for the Prior Condition. When comparing the difference between the two hemispheres, it was predicted that the left temporal lobe would have a higher mean alpha power in relation to that of the right temporal lobe in the 10s prior to game-play (Prior Condition).

Additionally, very few studies have examined the role of EEG patterns during the participant's actual performance on an activity due to the logistics of measuring an athlete during prolonged performance. Most studies examined athletic events with a single momentary visuo-spatial event like dart throwing or archery, but virtually none were able to record during an activity like basketball or long-distance running. By using the videogame designed for this study, EEG recording occurs over a prolonged visuo-spatial performance. Limited research indicates that decreased delta frequency (1-4Hz) during motor activity leads to higher performance (Crossroads Institute, 2005). Delta power indicates low arousal often associated with sleep, while decreased delta indicates high arousal and alertness, with the latter conditions advantageous in performance. For the present study mean delta power during the actual trial (Trial Condition) was hypothesized to inversely relate to improved performance.

Since the videogame allows for evaluation over the length of a performance as well as prior to the performance, EEG is most useful to the present study due its ability to record continuously. Thus EEG can reveal relationships between cortical activity over a period prior to a trial and to the participant's performance on that trial. Skin conductance was also analyzed for a correlation to performance. Since skin conductance measures arousal to a reliable degree (Andressi, 2000), a low skin conductance prior to performance and a high skin conductance during performance should relate to improved performance. Thus the present study included a skin conductance measure and predicted the aforementioned pattern.

Overall, prior studies suggest that a state of flow correlates with peak performance. The criteria for inducing flow include plain goals, immediate feedback, and an appropriate challenge to skill ratio. These criteria set the basis for creating a simple motor-response videogame with the intention of inducing flow. The present study utilized EEG to examine the neural activity associated with high performance on a flow-inducing task. Participants playing a videogame were predicted to show an increase in mean alpha power 10 seconds prior to a high performance trial (Prior Condition). Right hemisphere activation was predicted to remain stable prior to activity and have no predictive value for performance due to the stability of visuo-spatial reasoning for a trial (Prior Condition). Subtracting mean alpha power in the right temporal lobe from that of the left was predicted to have a positive relationship with trial length in the Prior Condition. Additionally, an inverse relationship between mean delta power, over both hemispheres, and high performance was predicted (Trial Condition). Low skin conductance was expected for the Prior Condition and high skin

conductance was expected for the Trial Condition, where both results predict high performance on the motor-response task.

2. Methods

2.1. Participants

The participants in this study were 5 male and 5 female volunteer undergraduate and graduate students from a large, private Midwestern University. All participants were right handed to ensure consistency for hemispheric differences.

2.2. Materials

Data collection was accomplished using Thought Technology Biograph Infinity Software (Thought Technology, Montreal Canada) run on a Hewlett Packard laptop PC. Both EEG and skin conductance were recorded on a Thought Technology Procomp Infinity Encoder and amplifiers (Thought Technology, Montreal Canada). Electrodes were 8mm molded tin cup electrodes placed at T3 and T4 based on the International 10-20 system. A shared reference was placed at FPZ and the ground at the nazion. The raw EEG signal was collected at a sampling rate of 256Hz, digitized and passed through a 60Hz notch filter to remove ambient electrical activity. Fast Fourier Transform (FFT) separated the raw data into individual frequency bands and was calculated as percent power. For parsimony, frequency bands were then grouped into 1-4Hz (delta), 4-8Hz (theta), 8-12Hz (alpha), 12-16Hz (low beta), 16-20Hz (midrange beta), and 20-24Hz (high beta). Galvanic Skin Response Sensors placed on the finger tips were used to record skin conductance in Simens (5-50micromohs).

The videogame was designed by Satoru Suzuki at Northwestern University using Vision Shell (version) and displayed on a 19 inch monitor, with the participant seated approximately .5m from the monitor. A Power Macintosh 8600/300 executed the program. The game consisted of a driving scenario in which a vehicle (the character "/\") is driven through a winding road (comprised of the character "|"). Turns in the road were random with a 3:1 bias in favor of staying straight. Each turn corresponded to one unit of the car. As the game progressed, the difficulty increased via a narrowing of the road at a rate of one car width every 75 car lengths past (that is, when the car has traveled 75 times its own length, the road narrows by one car width) until the road became three car widths across at which point the narrowing ceased; this point was considered the maximum difficulty. Movement was conducted through a left and right key press (the "z" key for movements to the left and the "/" key for movements to the right) and each press corresponded to one car-length movement. Scores were derived from length of game play with each point corresponding to a unit of wall passed.

2.3 Procedure

Participants began by providing informed consent while the electrodes were prepared. Electrodes were placed at T3 and T4 with the shared reference placed at the FPZ and the ground placed at the nazion. Skin conductance sensors were placed on the left hand on the ring and middle finger. Once ready, a 60s baseline was recorded in which participants stared at the blank screen. After the 60s baseline, participants were given these instructions: "Please control the car using the keys marked by a green and yellow sticker. Your goal is to avoid the walls for as long as possible". Following these instructions the game was started

using the Vision Shell software, the game was started and participants played for as long as possible. The beginning of a trial until crash was marked by the researcher using a marker feature imbedded in the Thought Technology Biograph Infinity software. After a crash, 15-30s of rest was recorded in which participants were allowed to relax before the next trial. Only the last 10s of rest before a new trial were used for analysis of the Prior Condition. The entire trial was used for analysis in the Trial Condition. Each participant played as many trials as possible for 25 minutes and a 60s baseline was recorded at the conclusion of the session. Any trials lasting past the 25-minute trial session were discarded.

Mean power for each frequency band was analyzed for both the Prior Condition and the Trial Condition. All frequency bands were subjected to a regression analysis using JMP software (SAS institute, Cary, NC). Initially hemispheric differences were evaluated by comparing analogous frequency bands. Next, bands were combined and regression analyses were conducted again in order to see any whole brain effects. Skin conductance was analyzed based on average skin conductance for both the Prior Condition and the Trial Condition and a regression analysis was used in a similar manner to that of the frequency bands.

3. Results

This study was designed to evaluate the relationship between electrical patterns of activation in the cortex and performance on a motor response task. A relationship between arousal and performance on the same task was also assessed. These relationships were analyzed using a regression analysis. Specifically, mean EEG power over several frequency bands was used to measure electrical patterns in the cortex. The independent variables measured were the individual frequency bands of 1-4Hz (delta), 4-8Hz (theta), 8-12Hz (alpha), 12-16Hz (low beta), 16-20Hz (midrange beta), and 20-24Hz (high beta). For arousal, a Galvanic Skin Response Sensor recorded skin conductance in Simens (5-50micromohs). Both measures were evaluated in two separate conditions. During the Prior Condition data was averaged for both measures over a period of 10s prior to the start of a trial. During the Trial Condition data was averaged for both measures over the length of the trial. The regression analysis was conducted using the formula:

$$\text{Duration of Trail} = a + b_1(\text{Skin Conductance}) + b_2\,(\text{1-4Hz LH}) + b_3\,(\text{4-8Hz LH}) + b_4\,(\text{8-12Hz LH}) + b_5\,(\text{12-16Hz LH}) + b_6\,(\text{16-20Hz LH}) + b_7\,(\text{20-24Hz LH}) + b_8\,(\text{1-4Hz RH}) + b_9\,(\text{4-8Hz RH}) + b_{10}\,(\text{8-12Hz RH}) + b_{11}\,(\text{12-16Hz RH}) + b_{12}\,(\text{16-20Hz RH}) + b_{13}\,(\text{20-24Hz RH}) + \varepsilon_{13}$$

In the Prior Condition, the predictors accounted for 12.3% of the variance in the duration of the trials, $R^2 = .123$, $F\ (13, 206) = 2.23$, $p<.05$. Examination of the individual predictor variables revealed a significant positive effect of skin conductance, (0.44), $t = 2.00$, $p<.05$. Such a result indicates that when all other variables were controlled, a 0.44 increase in skin conductance resulted in an increase in videogame play by 1s. The frequency band of 4-8Hz (theta) in the left temporal lobe also showed a significant effect as a predictor variable, (-2.67), $t = -2.32$, $p<.05$. The theta band for the right temporal lobe showed a positive significant effect, (2.44), $t = 2.25$, $p<.05$. A significant effect was found in the left temporal lobe for the frequency band correlating to mid range beta, (-4.11), $t = -2.70$, $p<.05$.

For the Trial Condition, the predictors accounted for 18.0% of the variance in the duration of trials, $R^2 = .180$, $F\ (13, 206) = 3.47$, $p<.05$. Examination of these individual

predictor variables revealed a significant positive effect of skin conductance as well, (0.775), t= 3.10, p<.05. The only other predictor variable that showed a significant effect was the mid beta frequency range (16-20Hz) in the left temporal lobe, (-4.17), t= -2.93, p<.05.

Again using a regression analysis, I evaluated the individual variables as differences in mean power between hemispheres (LH- RH). For the Prior Condition, the predictor variables accounted for 7.75% of the variance in the duration of trials, R^2= .775, F (6, 213) = 2.98, p<.05. When comparing the individual predictor variables as differences between mean power in the hemispheres the alpha frequency range (8-12Hz) had a significant effect, (2.13), t= 2.11, p<.05. This result agreed with the predictions of this study. The theta frequency range (4-8Hz) also revealed a significant effect, (-2.82), t= -2.27, p<.05.

Comparing the difference in mean alpha power between hemispheres for the Trial Condition showed that the predictor variables accounted for 8.89% of the variance in the duration of trials, R^2= .0889, F (6, 213) = 3.46, p<.05. Only the mid beta frequency range (16-20Hz) showed significance when comparing the difference between temporal lobes, (-4.11), t= -3.69, p<.05.

In summary, left hemisphere mean alpha power failed to show statistical significance (p=0.380 with an alpha level of .05) in the Prior Condition. Right hemisphere mean alpha power also showed non-significant results (p=0.0762). Such a result agrees with the predictions made in this study. A comparison of left temporal lobe mean alpha power versus right temporal lobe mean alpha power revealed a positive significant result (p<.05), which was also expected. For the Trial Condition, mean delta power did not show significance in either hemisphere (p=0.206).

Skin conductance showed statistical significance for both conditions, (p<.05 in the Prior Condition and the Trial Condition). The results for the Trial Condition showed support for the hypothesis, but the results for the Prior Condition did not.

Unexpectedly, mean theta power showed significance in the Prior Condition over both hemispheres (p<.05), but with a negative correlation to performance in the left hemisphere and a positive correlation to performance in the right hemisphere. This resulted in a statistically significant difference in mean theta power over the hemispheres (p<.05). Mid beta range frequency also showed significance over the left hemisphere in the Prior Condition (p<.05). For the Trial Condition, mid beta again showed significance in the left hemisphere (p<.05). The results of both conditions indicate that a decrease in mid range beta predicts performance. A statistically significant difference between left hemisphere mid beta and right hemisphere mid beta was also found in the Trial Condition (p<.05).

4. Discussion

The present study evaluated the relationship between electrical patterns and performance on a prolonged motor-response task. Specifically, electrical patterns measured by EEG were analyzed in the temporal lobes of each hemisphere and examined for their role in performance on a flow-inducing task. A videogame was designed to highlight Csikszentmihalyi's criteria of flow (1999). By presenting clear goals, immediate feedback, and a proper balance between challenge and skill, participants were likely to have the most success while in a state similar to flow. Past flow studies have generally focused on the behavioral results and showed that increased flow led to improved performance, but few have

examined the psycophysiological correlates (Kraus, 2003; Lindsay, Maynard & Thomas, 2005; Csikszentmihalyi, Abuhamdeh & Nakamura, 2005).

For the present study both EEG and skin conductance were measured prior to game play (Prior Condition) and during game play (Trial Condition) in an effort to discover the patterns of activation correlated with peak performance. Past research indicated that mean alpha power increased over the left temporal lobe for elite athletes prior to performance (Kerick, Douglass & Hatfield, 2004; Landers et al., 1994; Hatfield et al., 1984). However, these studies focused on highly skilled athletes and not the general population. This study sought to generalize these findings by presenting subjects of the general population a chance to perform a visuo-spatial task that does not require exceptional skill to master. Additionally, the videogame tested performance on a continuous visuo-spatial task as opposed to the single action tasks generally examined (i.e. dart throwing, archery, etc.). It was predicted that as performance improved, mean alpha power in the left temporal lobe would increase and right temporal lobe alpha power would remain the same in conjunction with past research. Also, prior to a trial an increase in mean alpha power in the left temporal lobe when compared to that of the right was predicted to positively correlate with improved performance. Additionally, this study examined the role of arousal in performance on a videogame. Decreased arousal in the Prior Condition, measured through galvanic skin conductance, was predicted to lead to better performance and increased arousal during the Trial Condition, as measured through skin conductance and decreased mean delta power, was also predicted to lead to improved performance.

Past research such as that of Landers et al. (1994) and Hatfield et al. (1984) found that an increase in mean alpha power in the left temporal lobe prior to a visuo-spatial task led to improved performance, however the present study failed to find a significant correlation between improved performance and alpha power in either temporal lobe. The hypothesis that mean alpha power in the right temporal lobe in the Prior Condition would remain stable was supported by the lack of significant results in this condition; however without the subsequent support regarding the left temporal lobe, this result has little weight. Still, a significant result was found during the Prior Condition when examining mean alpha power differences between the left temporal lobe and the right. Greater mean alpha power in the left hemisphere, when compared to that of the right, in the 10s before a trial resulted in improved performance. This indicates some support for the trends established by past studies.

The hypothesis that arousal, as measured by skin conductance and mean delta power, would positively correlate with performance was partially supported by the data. It was hypothesized that average skin conductance over the Prior Condition would negatively correlate with performance and average skin conductance over the Trial condition would positively correlate with performance. Both the Prior Condition and the Trial Condition showed a positive correlation with performance. The results of mean delta power analysis failed to show the expected negative correlation with performance.

Investigating other traditionally defined frequency ranges, a significant negative correlation was found for mean theta activity (4-8Hz), in the Prior Condition, over the left temporal lobe and a positive correlation was found for mean theta activity over the right temporal lobe in the same condition. Thus an increase in performance occurred when theta activity decreased in the left temporal lobe, and simultaneously increased in the right, over the 10s prior to a trial. A negative correlation between performance and mid beta activity (16-20Hz) was also found in the Prior Condition. The Trial Condition yielded a negative

correlation between mean mid range beta activity and performance. A brief discussion of these results will follow.

First, the specific pattern of increased mean alpha in the left hemisphere and maintained mean alpha in the right, as shown by Landers et al. (1994) and Hatfield et al. (1984), lacked full support from this study, however promising indications of similar activity were found. Significant results were not found for mean alpha during the Prior Condition, however a trend in the data indicates that a decrease in mean alpha in the right temporal lobe leads to better performance. The current theory on alpha activation proposes that "verbal thoughts are associated with a decrease in alpha in the left hemisphere and visual thoughts are associated with a decrease in alpha in the right hemisphere" (Vernon 2005). The trend found in this study suggests that a decrease of alpha power in the right hemisphere prior to a trial increases visuo-spatial processing leading to better performance and supports the work of Salazar et al. (1990).

Moreover, the increase in alpha power in the left temporal lobe 10s prior to a trial (Prior Condition) compared to that of the right was found to significantly predict performance. The difference between alpha power in the two hemispheres showed that the alpha activation in the left hemisphere should be higher than that of the right for an improvement in performance. Such a finding strongly agrees with the proposed pattern of activation indicated by Landers et al. (1994) and Hatfield et al. (1984). Even without a significant finding for each hemisphere independently, the interaction between the two supports the theorized correlation between alpha power in the left hemisphere and performance. Thus, such a finding seems to be robust; visuo-spatial tasks elicit a predictable pattern of activation whether the participant is an elite athlete or part of the general population. Previous studies have shown that inexperienced athletes do not exhibit the same EEG activity (Landers et al., 1994); however the present study was conducted entirely with inexperienced subjects. Such a finding implies a contradiction to past studies regarding EEG patterns in novice and elite athletes such as the work of Landers et al. (1994). Perhaps on a prolonged visuo-spatial task, a novice will show the same pattern of activation as that of an elite athlete performing a task of short duration. Landers et al. (1994) claimed that the increased alpha power in the left hemisphere only applies when an individual has habitualized the motor response. The results of this study indicate that when the motor response is continuous, all individuals exhibit the same basic activity.

On the other hand, the simplicity of the videogame may allow for a quick learning curve and thus the findings of the present study would be consistent with the research of Landers et al. (1994). Conceivably the participants in this study took very little time to become experienced and therefore differences in left and right alpha activity apply only to experienced participants. A much greater motor response is necessary for the aiming of a dart throw than the simple movement of the vehicle in this game and thus participants in this study may have habituated to the task almost immediately.

Alternately, the lack of strong findings in left temporal lobe activity may reflect a difference in novices when compared to experts. Landers et al. (1994) showed non-significant hemispheric differences for novice archers. The present study only showed significant results when performance was predicted by a difference in left and right activity, but lacked any significant results for left temporal activation when viewed alone. Perhaps strong left temporal activation prior to a visual motor-response task only correlates to improved performance in experts. Novice participants may show a reduced version of this

pattern, present only as a difference between left temporal activity and right temporal activity. Future areas of research might help discern between these possibilities.

Overall, a difference in left and right temporal alpha activity positively correlating to performance supports the idea that alpha activity inhibits cognition in preparation for another task (Salazar et al. 1990). If an improvement in performance can be predicted by a significant difference in right hemisphere alpha activity when subtracted from left, the idea that the left temporal lobe requires "quieting" to perform a visuo-spatial task seems plausible. Salazar et al. (1990) suggest that verbalizations occurring in the left temporal lobe should be inhibited by alpha activity prior to performance. Csikszentmihalyi et al. (2005) describe flow state as that of a low level of internal verbal thought; such a description lends itself to the conclusion that these two processes share similarities. Certainly flow states and differences in hemispheric alpha activation both lead to improved performance and further studies may reveal a more detailed relationship between the two.

Arousal also seems to play an important role in performance; increased arousal, indicated by high skin conductance, also significantly correlated with peak performance. Such a result suggests that high levels of performance over a prolonged motor-response task require maintained arousal. Additionally, it was predicted that skin conductance would correlate inversely with task success in the Prior Condition implying a state of calm prior to action. The opposite result was found indicating that arousal prior to performance (as well as during performance) leads to improvement.

Delta power has been well established as a correlate to sleepiness and a motor response task requiring arousal should hold an inverse relationship with such a state. No significant results were found regarding delta in this study, thus delta power appears to not play a role in predicting performance.

Other frequency bands, however, did show significance and may play a similar role. The significant relationship between mean theta power (4-8Hz) and performance in the Prior Condition is difficult to interpret. Theta activity is generally associated with memory encoding and retrieval (Gladwin, Lindsen & de Jong, 2006). Further complications result from the exhibited pattern of an increase in right temporal lobe theta activity accompanied by a decrease in left temporal lobe theta activity, in the Prior Condition, leading to improved performance. Very little literature exists on lateralization effects for theta activity in the temporal lobe, thus, although this finding is interesting, it was not predicted in this study due to a lack of prior literature.

Mid range beta activity (16-20Hz) occurring in the left hemisphere was also found to negatively correlate with performance in both the Prior Condition and the Trial Condition. In the Trial Condition, a significant result was found when comparing left temporal activity to that of the right. This indicates that, during a trial, maintaining higher mid range beta in the left hemisphere, when compared to that of the right, aids performance. Again, such a finding has not appeared in any of the literature reviewed for this study. Mid range beta activity has been linked to a state of alertness coupled with subjective feelings of self-awareness (Crossroads Institute 2005). Reducing self-awareness is part of the state of flow (Csikszentmihalyi 1999), however little empirical data exists to provide a rationale regarding a correlation between mid range beta activity and flow or performance. Overall, these findings are quite interesting and offer encouragement for future studies on EEG patterns and performance.

The results of this study concur with certain aspects of past research on performance and fail to support others. Since this study tested non-experts on a visuo-spatial activity, the

results make for a more robust finding. Elite athletes show increased alpha power over the left hemisphere prior to performance, and the present study shows that non-elite athletes show a similar pattern. However, level of expertise was not evaluated for this study. Additionally, only a comparison of left temporal alpha activity compared to right temporal alpha activity showed significance. Perhaps novice participants demonstrate a reduced pattern of alpha activity only. A possible future study examining the EEG patters in participants at different levels of expertise on such a videogame may shed more light on the true nature of this EEG pattern. Moreover, the pattern of arousal shown in this study indicates that a state of alertness is ideal during game play and before. Further analysis of arousal in future studies might reveal a more complete picture of the physiological correlates to peak performance.

Additionally, much of this study relied on Csikszentmihalyi's (1999) criteria for flow without actually testing these criteria. Establishing the degree of flow the videogame induces would create a stronger relationship between the neurological correlates of peak performance and flow. A state of flow seems to be useful for many aspects of life and discovering the EEG correlates for such a state allows for the possibility of biofeedback training. Helping individuals reach a state of flow consistently may aide in better performance on tasks ranging from athletics, to musical performance, to mathematical reasoning and locating the EEG correlates for such a state is highly valuable.

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David Hume on Miracles

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The purpose of this paper is to investigate the key claims and arguments of Section X, "Of Miracles," in Hume's *An Inquiry Concerning Human Understanding*. Hume says on p. 536[1] that "a miracle is a violation of the laws of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle, from the very nature of the fact, is as entire as any argument from experience can possibly be imagined." Hume believes miracles are unjustifiable from the fact that the whole course of nature, the universe, its laws, its order, all serve as evidence against it. "Commit it then to the flames,"[2] he will sternly conclude. By way of a negative causation[3], Hume will show that any belief concerning miracles or any matter of fact lacks a rational foundation. Then, by a positive analysis[4] of the same, he will show that beliefs are formed by the experience of custom and habit. The paper will also compare which probability is the more convincing: on the one hand, the testimony of witness, and on the other hand, the testimony of nature. Arguing normatively, Hume will conclude that assent *ought* to be given to that experience which is most probable and strong, which he will argue to be the testimony of nature. So while it may be the case that one believes in miracles, it can never be the case that one ought to, he will say.

First, we must understand Hume's argument. Miracles are "a violation of the laws of nature." The laws of nature are those constant conjunctions of observed experience that allow for the predictability of future events. From the establishment of these observations we can determine "laws." Now, a miracle is a violation of the system of observed data that gives occasion to laws. This is to say that when a miracle happens, an event occurs that is not of the ordinary. A person who comes back to life violates that law which says a man dead stays dead. Thus, there is an experience (a dead person coming to life) against a manifold of the contrary. Hume's argument states that you must weigh both experiences, look to the one that is most probable, and give assent to that one. By this method, the dead resurrecting is discredited.

Each miracle entails having a "uniform experience" against it. By uniformity, Hume means a constant manifestation of similar events that over time seem as one, like the formula "A then B." Miracles are a deviation from this uniformity, from those laws given to us by nature. Nature never changes and is always longstanding, or as Hume puts it, nature is the

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[1] Roger Ariew and Eric Watkins, eds. Modern Philosophy: An Anthology of Primary Sources. Indianapolis: Hackett Publishing Company, Inc., 1998, [Selection from David Hume, *An Inquiry Concerning Human Understanding*].

[2] This normative passage found in the closing paragraph of the *Inquiry* aims to attack metaphysics, theology and any field of study falling outside the bounds of logic, geometry, math and the empirical sciences.

[3] By "negative causation" I mean his consideration in establishing miracles as non-rational.

[4] By "positive causation" I mean Hume's way of affirming belief as merely customary and habitual.

"firm and unalterable experience," (*cf*. p.536). A miracle rejects this nature, or rather interrupts it in a manner offensively, and it stands alone in isolation against the uniformity of observed events.

Inductively, we take experience uniformly and are able to predict from past events what will follow in the future; the future resembles the past[5] and we bend our will to that experience or rather our will is bent by it. A miracle would interrupt the course of our beliefs, but it only ought to if that miracle can come in uniformity. If not, there is no rational foundation in believing in it. By its very nature, a miracle is a singular activity that brings with it "a uniform experience" against it, "other wise the event [miracle] would not merit that appellation. And as a uniform experience amounts to a proof, there is here a direct and full proof, from the nature of the fact, against the existence of any miracle…" (p. 536).

That successive and conjoining experience is a motif for belief arises from Hume's negative analysis of causality in Section IV of his *Inquiry*. In that chapter, he wants to investigate the impression from which we come to the idea of continuity and he finds it in a "relation of cause and effect," (p.500). A man who finds a foot print on the beach will conclude that someone walked there previously. He is able to make the connection, not by any reasoning *a priori* (negative causality), but through the manifold observation of the same experience (positive analysis). He has observed a thousand times before that a footprint relates to man, and this alone, this uniformed experience, enables him to connect the effect to the cause. Hume says that "this relation is not, in any instance, attained by reasoning *a priori*, but arises entirely from experience when we find that any particular object is constantly conjoined with each other." (p. 500). One almost intuits that this is the argument he will use later against miracles, and this is exactly what he does when he says in Section X that "the proof against a miracle…is as entire as any argument from experience can be possibly be imagined," (p. 536). Hence, as there is no rational foundation for connecting the footprint to man, since this connection is made by observed date, not *a priori*, he concludes negatively that there is no justified reason for believing in miracles.

Returning to Section X, Hume wants to consider the reliability of testimony. "No testimony is sufficient to establish a miracle," he says (p. 537). This is because testimony rests not in reason (again emphasizing his negative causality) but in human experience. Our assent to and belief in what others say initiates in custom and habit (positive causation, p. 535). That is, we place credence to that which we are accustomed to find in conformity with the real, (*cf*. p. 535). And when a witness testifies to what is not in conformity to reality, "the evidence resulting from the testimony admits of a diminution, greater or less in proportion as the fact is more or less unusual," (*Ibid*). Miracles are of the nature to admit a most probable diminution of evidence as there is no conjoining experience to call witness to it. The reason why miracles produce belief in the mass is due to reasons Hume will now consider.

First, credence in miracles lends itself to the ignorance of those who fancy with the imagination and live accordingly in primitive states. Belief in miracles is "observed chiefly to abound among ignorant and barbarous nations," (p. 538), and have a less likelihood to develop from a civilized people. Secondly, we tend to that which gives us a sense of pleasure, and what more provides this than those miracles that come to us as a *surprise* or as *wonder*, and which cause the same when we tell it to others. And thirdly, yet not the least, the testimony of miracles discredits itself, "so that not only miracles destroy the credit of

[5] *Cf*. p. 504, implication towards negative causation where it is not reason that enables us to form a belief about the future, but inductive experience.

testimony, but the testimony destroys itself," (p. 539). Hume compares the different religions of the world and how each one in some way or another vouchsafe to themselves miracles as the starting grounds for their existence. Muhammad's successors, (he will call them "barbarous Arabians") in positing their religion to be founded in miracles have the same authority in testimony as a Titus, a Plutarch, a Tacitus or a Roman Catholic who relate similar testimony, says Hume. In seeking to destroy the testimony of others, they "likewise destroy the credit of those miracles on which that system was established, so that all the prodigies of different religions are to be regarded as contrary facts," (p. 539).

Hume wants to convince us, using normative arguments, that there is no reason to believe in miracles. Experience is its own testimony against the testimony of miracles. We have proof against proof, and both proofs (though in actuality they are probabilities) rest in experience. One however is always the more superior and to believe in that one is always of the wise, says Hume. My belief towards that one which is most probable is not controlled by the will but by the laws of nature (*cf.* p. 509), and I ought to bend my will to that which is true. But for reasons already mentioned, people tend towards fiction. Though I may believe in miracles there exists a more probable likelihood that it is my imagination playing tricks on me than that it is an actual and true belief.

Hume is tireless in positing belief to be the product of custom. He fashions a descriptive analysis from his natural empiricism. He shows how beliefs are founded on sentiment and feeling. In distinguishing between imagination and belief, he reminds us that imagination or fiction is free from feeling, but not belief: "..the difference between fiction and belief lies in some sentiment or feeling which is annexed to the latter, not to the former, and which depends not on the will, nor can be commanded at pleasure. It must be excited by nature…", (*Ibid*) that is, custom or habit. And because miracles are a violation of custom and habit, there ought not to be a place for them in the will.

After these considerations, Hume now wants to weigh the testimony of witness with that of the testimony of laws. He sees there occurs a violation in both, and asks which violation is more frequently repeated. Almost immediately one acknowledges a more frequent abuse on truth than on the laws of nature. Man is more prone to cheat and deceit than nature's susceptibility is to suffer violation. He does not deny the existence of extraordinary phenomena or that it occurs. When and if it occurs, one must acknowledge that it will come with an exceedingly high and uniformed testimony, and that such testimony, as the one he hypothesizes about the eight hour eclipse in 1600 England followed by a number of credible witnesses, can be granted belief. However, such phenomena will have an undiscovered law attached to it, and "philosophers ought to search for the causes from which it might be derived," (p. 542). Following the comparison to this example, he puts forth another and says if someone was to say that the Queen of England died, came back to life and reigned three more years, though accompanied by many credible witnesses, it would be more probable that the event was "pretended" than it be real, and that such folly of testimony ought not to be passed without rejection. Hume says: "I should rather believe the most extraordinary events to arise from their concurrence than admit of so signal a violation of the laws of nature," (p. 542).

So the question to that which is most probable is a question that ultimately has to be judged according to that which is more experienced. Which is more credible; the violation of the laws of nature or the violation of truth? Experience itself is witness to the fact that men more often lie and deceive or are deceived, than that one single law of nature be interrupted and offended by the testimony of miracles says Hume, "…the violations of truth are more

common in the testimony concerning religious miracles than in that concerning any other matter of fact," (p. 542) and so we should "never lend any attention to it, with whatever specious pretense it may be covered," (*Ibid*).

In conclusion, we have seen Hume's claims in Section X, and how they connect to his previous arguments of negative and positive causation. Speaking as an empiricist in modern Europe, Hume acknowledges that miracles are a contradiction to science. He advocates for an empirical inquiry to make manifest the nature of miracles, by which investigation he hopes to convince the reader of the superiority of laws to that of miracles. Our feeling and sentiment ought to be placed on that which is more probable, he concludes. Commit then metaphysics, theology or whichever pseudo-science presents itself outside the bounds of sense experience, to the flames, and include in those flames superstitions, miracles and like phenomena, "and whoever is moved by faith to assent to [miracles] is conscious of a continued miracle in his own person which subverts all the principles of his understanding and gives him a determination to believe what is most contrary to custom and experience," (p. 543). Once you understand Hume's definition of miracles, you understand that you can never have reason to believe in one.

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From Here to There: A Sociolinguistic Study in Gender and Direction-Giving

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1. Introduction

How do we get from here to there? It is clear that men and women explain things differently, but how much variation is possible in giving step-by-step instructions for a common task? If there is variation in these directions, how can we explain its origins? Carol Lawton, who studied the ways in which men and women give directions for spatial tasks, stated, "the pattern of gender differences that has emerged from research on navigation and wayfinding shows that men excel on some tasks and women on others." (322) Conclusions like Lawton's that claim that linguistic gender differences arise from variations in related sub-sets of cognitive strengths are supported by what sociolinguist Jennifer Coates referred to as the "difference approach" to describing how men and women use language. This approach "emphasizes the idea that men and women belong to different subcultures… researchers have been able to show the strengths of linguistic strategies characteristic of women [and men]" (6). In my study entitled "From Here to There: A sociolinguistic study of gender and direction-giving," I was not only concerned about the differences in responses to the direction-giving tasks that I asked of my respondents. Also, I wanted to know if these differences are due to inherent variations in the way that men and women use language, the frequency of certain linguistic markers, the effects of the nature of the study on the types of responses given, and the performance of each gender on two different types of tasks.

I modeled my study most closely on Carol Lawton's "Gender and Regional Differences in Spatial Referents Used in Direction Giving" (2001), although I compared my methodology and conclusions to other studies that also tracked gender differences in direction-giving tasks, both spatial and otherwise. In the first part of my paper, I will discuss direction-giving studies, in particular, Lawton's study. I will then discuss my study's methodology and the ways in which my study compared to Lawton's and as well as that of other similar studies. Next, the paper will focus on the responses that I received for my study and how these results were converted into numerical data using statistics. Finally, I will evaluate my hypothesis in light of these findings, discuss the ways in which the methodology of my study may have affected the responses that I received, and briefly address changes that I would make for future studies on direction-giving.

1.1. An Overview of Direction-Giving Studies

During the initial conception of the focus of my study on direction-giving, I surveyed a variety of studies done on direction-giving for spatial tasks and found that the overarching view of these linguistic gender differences was that men and women are both able to give

perfectly adequate directions and it seems that they operate on some shared conceptual skills, they have different cognitive strengths that influence the ways in which they respond to direction-giving tasks. Men and women both support the directions that they give with the use of analogies, hand illustrators, and hierarchical messages ("the order in which people describe a collection of objects or rooms from a spatial layout" (Plumert et al. 478)) to describe object locations; in other words, both genders use these strategies as both linguistic and paralinguistic markers to enhance the quality of their directions.

In terms of particular strengths, however, men generally tend to include a higher frequency of references to cardinal directions, distance information (for example, the estimation of distances to landmarks), serial orientation (using words to describe the steps of the directions as a series: "first," "second," etc.) (Boerger & Henley, 1999; Cohen, 1977; Plumert et al., 1995). Men also excel in pointing to out-of-sight markers, locating hidden targets, and creating sketch-map drawings. On the other hand, women are more likely to refer to right/left turns ("At the stop sign, make a right.") and markers ("There will be a stop sign on your right.") and landmarks along the directional route. Women also show greater accuracy in remembering landmarks and their locations, identifying objects in a changed location and order, placing previously seen objects on a map, and recalling landmarks and street names from a map.

In short, men portray more explicit "pictures" of the directions that they give based on the location of a variety of objects, but women's directions are more explicit in their content, using specific names and being able to adapt their directions to unforeseen circumstances, such as changes in object location, approaching landmarks from different starting points, etc (MacFadden et al., 2003; Friend, 2001; Lawton, 2001). One theory suggested by Thomas Parsons and his colleagues states that these differences in conceptual strengths originate during development, when men and women establish patterns in cognitive performance that influence their abilities to perform linguistic, visual, auditory, and sensorimotor tasks. This claim about cognitive functioning and its relationship to gender will be examined further in the "discussion" section of this paper.

The hypothesis of Carol Lawton's study, "Gender and Regional Differences in Spatial Referents Used in Direction Giving" (2001) operated on these fundamental assumptions of gender-based strengths in task performance. Lawton suspected that not only would respondents give directions differently based on their gender, but also that the use of certain markers in their responses was a function of their geographic location due to differences in historical land partitioning. For example, male subjects would be more likely to use cardinal markers, but females would also use these markers if they were from the Midwestern United States, as land boundaries and markers were originally established based on their cardinal relations to others.

Lawton asked men and women from all areas of the United States to submit written directions to a location approximately fifteen minutes away from their homes. She conducted her study via website (the website contained the survey question and responses were submitted to the site), selecting a sample of 240 participants from 492 respondents over the age of 18. 154 of Lawton's respondents were females and 86 were males; in the in the interest of uniformity, only directions based on driving to the destination were used. Directions were coded for route information according to the following criteria: cardinal directions, mileage, right/left turns, buildings, topographical features, and traffic lights/signs. These criteria were chosen because they addressed both abstract (mileage, cardinal directions, right/left turns) and concrete (buildings, topographical features, traffic

lights/signs) markers and techniques that would hypothetically be used in a higher or lower frequency depending on the respondent's gender. The following is one example of a respondent's set of directions that used several examples of route information (Lawton substituted letters for actual street names):

> … Turn left off of Street A onto Street B. You are now going west on Street B. Continue on Street B for several miles, going through several stoplights. You will pass a mini-mall, and an insurance building with a big Christmas tree out front. Shortly after the insurance building there is a Burger King. Immediately after Burger King is Street C. Turn right on Street C. Continue straight on Street C for about a mile, and turn left… (329)

In this excerpt, we can see indicators of right/left turns ("Turn left off of Street A"), cardinal directions ("You are now going west on Street B"), traffic lights ("Continue on Street B… going through several stoplights"), mileage ("Continue on Street B for several miles"), buildings ("You will pass a mini-mall"), and topographical features ("Immediately after Burger King is Street C").

2. Methods

Like Lawton, the goal of my study was to see if males and females used different types of route information in order to give spatial directions. However, I was less interested in the influence of geographic location, but rather the content and complexity of the respondents' directions as a function of the goal of the directions. To find gender differences in spatial information tasks as opposed to other types of tasks which also required step-by-step directions, I asked my respondents to complete a spatial task as well as a neutral task. The neutral task was important to my study because I wanted to see if the cognitive differences that affected the gender differences in spatial directions would have a similar impact on other directional tasks.

My study was directed at students familiar with the Wellesley College campus, so the directional task was to give directions from the coffee bar on the first floor of the Lulu Chow Wang Campus Center to the main entrance of the Science Center. The neutral task was to give directions as to how to make a grilled cheese sandwich. My hypothesis stated that females would give longer, more complex directions (more words, steps, and words/step); males would use more topographical and directional markers in spatial tasks; and females would give more explicit directions for neutral tasks.

I solicited responses from students at Wellesley College and Olin College of Engineering, and received a total of 18 responses (9 male and 9 female); unlike Lawton, I performed my study with an equal number of male and female respondents. Subjects ranged in age from 18-22 and were all full-time students at Wellesley and Olin, respectively. The requirement for participation was that the subject be familiar with the Wellesley College campus, and the survey directions were as follows:

1. Tell me how to get from the coffee bar in the Lulu to the main entrance of the Science Center.

2. Tell me how to make a grilled cheese sandwich.

I solicited and collected responses via email. For both tasks, I recorded the total number of words for each response, as well as the total number of steps (this was determined based on the way that the subject presented the response, either with numbered steps or bullet points, or, if no steps were clearly delineated, I determined where steps began by progression markers such as "first," "next," and "then," or by sentence changes) and the average number of words per step.

My coding criteria for Task 1, the directional task, were based on Lawton's study, as well as additional criteria from similar analyses of gender and direction-giving. In a study about direction-giving and object placement, Jodie Plumert and her colleagues (1995) coded subject's responses for their frequency of place markers. Plumert's subjects were asked to give directions about where objects were placed in a room and their responses were coded for levels of spatial information—"floor, floor part, room, room part" (482)—as well as environmental information—"large landmark, large landmark part, small landmark" (482). Alastair MacFadden and his colleagues also focused on the frequency of subject references to landmarks in a study of how men and women scan maps (2003), however, in this experiment, data were collected from verbal rather than written responses. Although I did not use all of Plumert and MacFadden's coding criteria, their methodologies influenced the way that I organized my study.

In Task 1, I coded for cardinal directions, right/left markers, buildings, and topographical features. References to cardinal directions and right/left markers indicated the subject's knowledge of abstract directional concepts, and references to buildings and topographical features tested the subject's awareness of the environmental surroundings as relevant to the goal of the task. In choosing my criteria for Task 1, not only did I want to determine whether or not my respondents were explicit in the directions that they gave, I wanted to see if they referred to abstract as well as concrete markers.

On the other hand, the coding criteria in Task 2, the neutral task, were original; I coded for references to objects used, simultaneity in steps (this was determined as present when the subject indicated that the person following the directions should be doing more than one thing at a time; for example, "While the pan is heating up, put a slice of cheese between two slices of bread.") ingredients used, and task complexity. As in Task 1, I chose these criteria to test for abstract and environmental knowledge. References to simultaneity and the degree of complexity of the response indicated whether or not the subject assumed that the person following his directions would be familiar with the task; this "meta-awareness" demonstrated abstract thinking on the part of the respondent. References to objects and ingredients indicated the subject's awareness of environmental resources that may be available in order to complete the task.

I will discuss the statistical relevance of the coding criteria for Tasks 1 and 2, the ways in which I analyzed the survey responses in the following section.

3. Results

For the statistical analysis of my data, I first looked at the total words, total steps, and average number of words per step for each gender group and task. Then, I examined each subject's survey responses and marked references to each of the coding criteria by hand. I

put the total number of references into an Excel spreadsheet, sorting the figures based on gender and task. I then found each gender's average number of references for each category of coding criteria. The averages for each gender group and task are shown in Table 1

Table 1.
Gender Group Response Averages

Task 1—Spatial	Females	Males	**Task 2—Neutral**	Females	Males
Words	201.333	63.778	**Words**	99.222	111.889
Steps	7.667	3.444	**Steps**	6.111	6.111
Words/step	23.967	14.764	**Words/step**	15.736	17.882
Cardinal directions	0	0.444	**Objects**	2.111	3.111
Right/left markers	7.222	1	**Simultaneity**	0.222	0.111
Buildings	3.778	2.556	**Ingredients**	2.778	3.444
Topographical	16.333	3.667	**Complexity**	2.333	3.111

From these results, it is clear that females outperformed males on the spatial task in all categories except references to cardinal directions. Females showed significantly higher references to right/left markers and topographical features; their directions were also longer and sorted into more steps. On the other hand, males responded particularly well to the neutral task. Interestingly, their directions had a higher average word count, although both gender groups used the same number of steps; therefore, it would seem that, as in Task 1, females are more inclined to use multiple short steps rather than a few long steps to describe a task. In addition, male directions ranked higher than females on the complexity scale in Task 2.

After taking the averages for each category of coding criteria, I submitted this data to t-tests in order to show potential significant statistical differences between gender groups. The graphs of the averages and standard deviations for each category can be found in Appendix I; the arithmetic means and the P (T <= t) values for each task and category are shown in Table 2.

From the statistical analysis, we can observe trends in each task. In Task 1, there is a significant statistical difference in the words and cardinal directions category. In terms of total words count, the directions that females gave were substantially longer than those of the males. On the other hand, because no female subjects referred to cardinal directions in their responses, there is a considerable difference in this category in favor of the males. In Task 2, we can observe that there were significant p-values in the ingredients and complexity categories; in both of these categories, the males gave more data than their female counterparts.

Table 2
Arithmetic means and P values for each task and category

Task 1—Spatial	Mean—Females	Mean—Males	P-value	**Task 2—Neutral**	Mean—Females	Mean—Males	P-value
Words	201.333	63.778	0.056	**Words**	99.222	111.889	0.637
Steps	7.667	3.444	0.845324	**Steps**	6.111	6.1111	1
Words/step	23.967	14.764	0.96876	**Words/step**	15.736	17.882	0.198152
Cardinal directions	0	0.444	0.02075	**Objects**	2.111	3.111	0.195016
Right/left markers	7.222	1	0.93753	**Simultaneity**	0.222	0.111111	0.922805
Buildings	3.778	2.556	0.48684	**Ingredients**	2.778	3.444	0.036942
Topographical	16.333	3.667	0.93233	**Complexity**	2.333333	3.111111	0.011717

4. Discussion

While analyzing the numerical data of my study, I considered some of the effects that the methodology of my study may have had on the results that I collected. Due to the limited time and resources that were available to me when conducting this study, I was not able to solicit answers from a large number of respondents. In addition, the female respondents had a natural advantage on Task 1: as Wellesley College students, they were more familiar with the Wellesley campus than the male respondents. If I were to repeat this experiment, I would at least balance out the number of female respondents by using an equal number of Wellesleyand non-Wellesley students (female students from Olin College, for example). However, the males may have had an advantage on Task 2. From spending a significant amount of time at Olin College, I have concluded that Olin students cook more than Wellesley students, as they have modernized kitchens with communal cooking equipment; Wellesley students tend not to cook often due to limiting schedules, outdated or dirty facilities, and lack of communal equipment available.

The current survey questions in turn elicited some negative feedback. Initially, the Task 1 question was not to find one's way from the coffee bar in the Lulu to the Science Center, but rather from the same starting point to the Knapp Center in the Margaret Clapp Library. Many of my Olin respondents said that, although they were familiar with the Wellesley campus, they did not know where the Knapp Center was and therefore could not complete the task. Therefore, I had to change the directions of Task 1 to be for a simpler destination, but even after this change, respondents confessed that they found the task difficult, and many respondents chose to begin their directions from the outside of the Lulu rather than from the coffee bar. Even after these changes, two male respondents still claimed that they were unable to give directions for Task 1, so the overall male results had to take into account two subjects who did not submit responses for the spatial task.

I had a similar problem with Task 2: initially, I asked subjects to tell me how to make a turkey club sandwich, but again, my respondents, especially vegetarians, claimed that they

could not give directions for the task. Once again, I modified the survey question to ask for directions to make a grilled cheese sandwich, which I deemed to be a simpler, vegetarian-friendly task.

In addition to the initial change in my survey questions, many of my respondents raised other issues that I suspect may have affected the form and content of the directions that they submitted. Because I purposefully wrote vague survey questions, some of my subjects expressed concern that they did not know who the audience or recipient of their directions would be. Fredric Rabinowitz and his colleagues conducted a study about the ways in which men and women are helpful to lost tourists by giving directions (1997). Rabinowitz and his colleagues found that depending on the gender, age, language, and assumed socioeconomic status of the tourists, subjects would unconsciously modify the form of the directions that they gave. Thus, I predict that if I told subjects to write directions specifically for a friend, a parent, or a professor, then each set of directions would have different linguistic characteristics.

Another factor which may have affected the subjects' responses was that the surveys were done over email rather than in person. Had I asked the subjects to give directions in face-to-face interviews, I might have been able to not only observe the ways in which subjects verbally explained directions, but the potential use of hand gestures and bodily movements as relevant to the task that they were trying to explain. Akiba Cohen stated that paralinguistic "illustrators", which I would have been able to observe had I asked my subjects to give directions in person, could serve an "*encoder* [emphasis Cohen's] function when the encoder uses illustrators in order to help process the information in the message being received" (55). Cohen believes that paralinguistic cues enhance the information that the "encoder" is trying to convey because they "[create]… illustrators as if 'drawing a map' of the situation, while encoding the message verbally" (55). My subjects were information encoders in a restricted sense, however, because submitting their survey responses via email only allowed them to communicate verbal information and left out the potential for paralinguistic illustrators. Therefore, as Cohen would probably argue, the quality of the information that they encoded may have decreased.

Although the ways in which subjects presented their survey responses probably influenced the content and quality of the directions that they gave, the ways that I analyzed my data may have also affected the conclusions that I was able to draw. Until completing this study, I had never used statistical formulas to work with data. Initially, I was unsure of how to run t-tests and standard deviations; I also did not know what p-values I should be trying to detect and how the significance (or lack thereof) of these values would change my initial hypothesis. In addition, I unintentionally violated some statistical practices by performing t-tests on each other coding criteria for each task, rather than on selected criteria (although I would not have been sure as to which criteria I would select for the t-tests). In short, I believe that my statistical analysis and resulting figures may not be entirely reliable.

5. Conclusions

In light of these factors which may have affected my project's data, I was nonetheless able to reevaluate my hypothesis and draw conclusions about how men and women give directions differently, especially in regard to these directions' complexity as dependent on the task at hand. My original hypothesis had three parts, stating my belief that: females will

give longer, more complex directions (more words, steps, and words/step); males will use more topographical and directional markers in spatial tasks; and females will give more explicit directions for neutral tasks. However, I found that the results of my analysis did not support these predictions.

Females gave long and complex directions, but only for Task 1; this was probably due to the fact that they were more familiar with the goal of the task and the spatial information being asked of them than the male subjects. These results are also supported by Alastair MacFadden and his colleagues, who found that "a topographic strategy is typically evident among females, who describe landmarks along a route and transpositions using an egocentric (right/left) frame of reference" (297). On Task 1, Males also used fewer topographical markers than females, which I believe is due to the fact that, logically, they are less familiar with the Wellesley campus than Wellesley students. However, the male subjects did refer to directional markers at a higher frequency than the females; according to MacFadden, this is because "males recall more cardinal directions… and distance information than females when describing mapped environments from memory" (297).

MacFadden justifies these claims as to why men and women process and present spatial information differently by citing similar research on gender and cognition by Miller and Santoni (1986). Miller and Santoni concluded that these gender-based linguistic differences were due to "sex differences in the reliance upon topographical versus Euclidean aspects of spatial arrays in constructing internal maps" (297). Parsons and his colleagues, in their study of gender differences and cognition among adults (2005), believe that these differences in cognitive processing according to gender originate and are found in childhood, become established in adolescence, and continue to affect the ways in which men and women conceptualize information well into adulthood.

However, what Miller and Santoni seem to be inferring is that when presented with tasks that incorporate spatial information, both men and women base their responses on the internal creation of mental "maps" that both serve as a visual analogy of the task at hand and which help them to use a sort of inductive reasoning to work from the destination of the task in order to conceptualize the steps that it will take to reach this destination. I suspect that if I had provided the respondents with the opportunity to make maps for the spatial task as supplements to the written directions, not only would the written directions have changed slightly, but by having the subject create visual representations of the task at hand, I may have been able gain insight into what the subjects' internal maps looked like and how these maps supplemented the verbal information of the directions.

Finally, it was the males, rather than the females, who performed the best on the neutral task, contrary to my expectations. Perhaps males performed better on the neutral task because they felt that it was more appealing than the spatial task. Similarly, males might have performed better on Task 2 because their uncertainty with Task 1 led them to want to compensate for this deficiency by giving better and more explicit responses to the next task; it is possible that I could have avoided this "compensation effect" by changing the order of the tasks for half of my subject pool in order to balance out the effect. Additionally, males residing in Olin may just be more creative in the kitchen than Wellesley students; this higher overall performance could be due to Olin's better cooking facilities and resources, their limited on-campus dining options, or simply because the majority of my male subject pool were very good at making grilled cheese sandwiches.

It seems that the male respondents' abilities to perform well on Task 2 may also be due to differences in perception and cognitive processing. MacFadden and his colleagues stated

that "males have shown more aptitude than females for using [information based on the description of space based on a Euclidean survey-level perspective] in real-world and pencil-and-paper navigation tasks" (297). By MacFadden's characterization of men's cognitive processing, it may be possible to say that they are better at planning tasks based on the ability to see the task from a subjective, "surveyor" perspective, rather than step-by-step. On the other hand, females plan tasks with a better understanding of the objects involved and with more specific steps; however, since making a grilled cheese sandwich is not a task in which many objects are used, it is possible that the female subjects did not perform as well as the males because the task was not sufficiently complex and object-intensive.

The conclusions that I have drawn about gender and direction-giving seem to support the difference approach to sociolinguistics: as the results of my study and others have shown, men and women give directions differently because they have different conceptual strengths and perspectives. In "Think Practically and Look Locally: Language and Gender and Community-Based Practice," Penelope Eckert and Sally McConnell-Ginet state that linguistic differences between genders may also be affected by power dynamics.

Looking at language and gender from an anthropological standpoint, Eckert and McConnell-Ginet organized their data based on "difference on the one hand (especially the male power as a component of gender identities) and power on the other hand" (462) and sought to "shift attention away from an opposition of [difference and power] and toward the processes through which each feeds the other to produce the concrete complexities of language as used by real people engaged in social practice" (462). In short, the implications of the Eckert and McConnell-Ginet's study are that, just as we do not live in a vacuum, the majority of our speech operates on and reflects social norms. However, I do believe that by society's standards, gender stereotypes, linguistic and otherwise, are based on differences—inherent, factual, or assumed. Although direction-giving is a topic that is gender-neutral, the results of my study show conceptual and linguistic differences between men and women and thus these differences have the potential to further influence linguistic stereotypes based on gender.

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Conservation of Number Task with Small and Large Quantities on Male and Female Preschool Children

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1. Summary and Introduction

Revolutionary psychologist Jean Piaget reasoned that early development occurred in a specific stage-like manner. Through extensive research and experimentation Piaget concluded that development occurs in stages, with a qualitative shift in the organization and intricacy of cognition at each specific stage. Piaget categorized the steps of children's early development in to four specific stages: sensorimotor, preoperational, concrete operational and formal operational. As he presented his theories Piaget carefully emphasized that children are not less knowledgeable or slower than adults, they understand the world in a distinct way. Through the categorization of children in to distinct stages Piaget began to understand what tasks children were capable of performing at a given stage. At the preoperational level (roughly ages 2-7) children posses symbolic thought, can apply logical principles to symbols (not objects) and can perform reversibility, identity and compensation tasks. However, many children during Piaget's preoperational stage are not cognitively developed enough to succeed at conservation tasks. Piaget came to the conclusion that children fail at conservation tasks due to the fact that their thinking is not governed by principles of reversibility, compensation and identity just yet. As with any study, this particular research paper contains five important features which outline the idea being addressed and hypotheses that will be tested. The central phenomenon in this study is the phenomenon that young children have the ability to conserve with numbers at a preschool level. The linking hypothesis addressed in this study is that young children will have the ability to actively conserve using numbers grouped in small amounts at the preschool level.

Susan A. Rose and Marion Blank (1974) conducted a classic study which investigated the effects of certain types of question on children and the responses children produced. The central phenomenon of the Rose and Blank study was the manner of questioning the children in typical conservation tasks and the child's subsequent response. Rose and Blank's considered two specific linking hypotheses in their study. The first hypotheses stated that when the child has just declared the rows equal (or unequal) he interprets the request for a second judgment as a signal to change his response. When the subject is not in this predicament (having to judge the arrays once), he is more likely to respond to the correct central demand (the evaluation of number). Rose and Blank's second hypothesis implicitly states that children would have an easier time successfully completing the one judgment task because there would be no pressure for the subject to gauge the researchers intentions or intended response from the subject. Alternately, children will perform the same on all tasks regardless of contextual cues given by the researcher. The independent variables or variables

that were manipulated, in Rose and Blank's study are age, gender and assigned condition (to a standard conservation test, a one judgment task, or a fixed-array task). For a standard conservation test objects were lined up in a 1:1 ratio, the children were asked if the rows were equal then one row was expanded or contracted and then children were ask again whether or not the rows were equal. In the one judgment task the children watched the experimenters manipulate the objects and were subsequently asked if the two rows were equal. Finally, the fixed-array task consisted of not giving an initial set of chips with a 1:1 ratio and solely asking the children if two manipulated rows were equal. Ultimately the dependent variable, or what the researchers are measuring, is the ability to conserve number in a standard conservation test in comparison to a task where the manner in which the children are questioned is altered (e.g. initial questioning is omitted).

A similar study conducted by Gerald A. Winer (1974) investigated the occurrence that young children can, in fact, conserve number when tested with small quantities. Winer's findings suggest that the child's understanding of small quantities might possibly play a role in the development of conservation of larger numbers. The central phenomenon Winer's study explores is whether children will have a higher ability to conserve number in an experiment when tested with small quantities rather than large quantities. Winer's linking hypothesis stated that younger children are tested with small quantities will have a higher ability to conserve number than those who are tested with large quantity sets. Alternately, despite the evidence of conservation found, it may be that young children cannot perform or be tested on ability to conserve. The independent variables Winer controlled for are age, gender and condition order (i.e. small then large quantity or large then small quantity). The small quantity contained approximately 3-4 chips while the large quantity condition contained 5-6 chips. The dependent variable measured in Winer's study was the child's ability to conserve number in each condition (small or large).

Many previous studies have tested the extent to which children of different ages can conserve. Relatively all evidence gathered from these studies suggest that young children cannot conserve on standard tests (e.g., Beilin, 1968; Piaget, 1968; Rothenberg & Courtney, 1986).

2. Methods

A similar study to Winer's was conducted on March 21, 2006 at Vanderbilt University Child Care Center in the Stallworth Building on Vanderbilt University Campus in Nashville, Tennessee. Subjects included 3-year-old and 5-year-old male and female children attending the preschool. The preschool included indoor and outdoor play and learning facilities. The conservation study was conducted at a small classroom table in one of the classrooms. More specifically, tests were administered to an energetic and intelligent Caucasian 3-year-old girl and an outgoing and rambunctious Caucasian 5-year-old boy. Upon arrival to the child care center I explained my project to the supervising teacher and asked to administer my test to two of the children (a 3-year-old girl and a 5-year-old boy). Once the teacher had selected two willing students, I played and conversed with the each child to familiarize myself with the child. After becoming familiar with the child I led them in to the classroom to "play a game with numbers" and subsequently conducted our conservation experiment on each child.

To test ability to conserve using small and large quantities I assigned each child to a specific condition. No pretest, posttest or training was administered prior to the experiment. I utilized two different conditions which dealt with the order of varying chip quantities. The condition that the girl received included giving the girl a small quantity and then a large quantity. The boy was given the same task but in reverse order (large quantity and then small quantity). I then gave each four different trials for both the small quantity and the large quantity conditions. The four trials administered were the following: (1.) The child was shown two equal rows (a 1:1 ratio), a chip was added or subtracted from one of the rows and the child was asked 'Do you have more or do I have more, or do we both have the same number of chips?' (2.) The child was shown two equal rows (in a 1:1 ratio), one row was either expanded or contracted with a chip added to the shorter row or taken away from the longer row. The child is then asked the original question. (3.) The child is shown two equal rows (in a 1:1 ratio), the experimenter expands or contracts a row, a chip is either added or subtracted from each row, the experimenter then asks the subject the original question. (4.) The child is shown two equal rows (in a 1:1 ratio), one row is either expanded or contracted, and the child is asked the original question. If the child gives a yes or no response or uses a headshake to answer and gives no reason for his or her answer, the experimenter inquires of the child, "Why do you think that is the answer" or "How do you know this?" While conducting the experiment on the child, I recorded the child's answers on to a results sheet. Once the data was thoroughly collected it was organized in to a data spreadsheet (attached).

The experiment focused on the ability to perform number conservation with small and large quantities of chips. In recording and measuring responses for each condition (the 1:1 ratio condition and the conservation task condition) a child was given a score of 0 if her or she did not respond correctly (i.e. responding correctly to whether or not groups of chips were equal). A correct response is defined as an answer of 'yes' to the question 'are these rows equal?' in the 1:1 ratio condition and the number conservation condition when rows contain equal chips.

3. Results and Discussion

My observations included many findings of particular interest (Figure 1). Since I conducted an array of trials we found more variation in the individual trial results. My first trial was especially different than the fourth conservation trial. I found that in a 1:1 ratio children were able to gauge number, as they provided the correct answer to my investigative query. But, when a chip was either added or subtracted, the same child was not able to gauge the conservation operation. In this first trial the ratio was a 1:1 ratio and then added or subtracted a chip. When a chip was added or subtracted while the rows are still in a 1:1 ratio I found that children were able to recognize the change and deliver the correct response (that the rows were equal). The results of this task illustrate that the children had some concept of the numbers and the change occurring to the numbers although the children were too young to even count.

Another particularly interesting finding was that the 5-year-old boy tested focused on the properties of the individual chips uttering phrases such as, "this row is bigger because those chips are bigger." This boy focused on the chips as individual objects and not as a long row. When asked 'is the row bigger?' the boy would respond with an answer specific to the specific chips and not the overall row of chips.

Table 1
Experimental Results

Age	**Order**	**Correct Response?**	
		1:1 Correspondence	*Stretch*
3	1	0	0
3	2	0	0
3	1	1	0
5	2	0	0
5	1	1	1
5	2	1	0
Order			
1 = small to large			
2 = large to small			
Response			
0 = no			
1 = yes			

In addition, it was also quite noteworthy that towards the end of the experiment conducted on the 3-year-old girl, the girl started to organize the chips in different ways, contracting and expanding them, proving that she was starting to understand the operations I was performing. The girl showed that she cognitively understood the operations being performed on the chips by independently organizing the chips at the termination of my experiment. One could see the physical expression of confusion on the girls face as she manipulated the chips trying to organize them in contracted and expanded rows.

In regard to the total observations researched, results gathered from this experiment are consistent with the alterative hypotheses of Winer's current study but not Rose and Blank's classical study. Although both the classic and current studies focus on conservation in children, context of questioning (the attention of Rose and Blank's study) was not taken in to account in this study. My results fit with the alternate hypotheses of the current study due to the observation that only one child out of the six tested was able to successfully conserve the number of chips and report the correct answer. However, my study does not fit with Winer's linking hypothesis because Winer suggests that young children will be more successful in number conservation when given small numbers. This was not the case in my study, as only one child was able to conserve number. Even children given a small quantity of chips were not able to conserve, contradicting the linking hypothesis proposed in Winer's article. I found that the quantity order in which the child was assigned to did not make a difference in whether or not the child was able to conserve. This finding may suggest that children ages 3 and 5 do not have the ability to conserve number in any manner.

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Sharing the World: Nativism, Embodiment, and Metaphysical Localization

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1. Introduction

You and I share the world in a meaningful sense that exceeds the mere common denominator of a physical space; we can interact and communicate by understanding each other's intentions in a genuine manner. Curiously, we seem to have escaped the explicit chaos of Quine's radical translation, building a world brimming with interpersonal systems where collaborative efforts have enabled the work on science.

In this paper, I explore how it is that a person can meaningfully share the world with others, and how significant this phenomenon really is. It is my thesis that a person's native properties and nature of embodiment strongly participate in her relationship with reality by essentially carving out an aspectual side that forms her *perspective* of the world. Persons share similar perspectival views of the world by virtue of the similarity of their relationships with metaphysical reality.

The project is split into three movements; in the first I compose a metaphysical account of ontology and discuss how a person perceives objects and such by *abstracting* from within this metaphysical reality. I will attempt to demonstrate how this process of abstraction is essentially *framing*. The second portion of the paper focuses on what native properties and embodiment are, and how persons who possess them in likeness are metaphysically localized onto the same "band" of reality, allowing for meaningful interaction. The final segment will be an attempt to reframe the A.I. project as an attempt to create silicon brothers local to our metaphysical existence, and its implications will be carefully considered.

This could be construed as an ambitious project, and I may fail to give an adequate treatment of the subject. Time constraint and my technical inadequacy will restrict me to sketching my proposal in broad strokes, but it is no matter. My concern will be to convey a rough, original idea that is meaningful, potentially productive, and significant to our sense of existence.

2. Metaphysics & Ontology

This discussion focuses on the nature of reality as it is independent of perception, as well as how it participates in the process of being perceived. I will utilize some of Brian Cantwell Smith's (1996) established concepts and terminology to facilitate my arguments, since my metaphysical picture somewhat parallels that of Smith.

I feel complied to give a justification as to why the dive into metaphysics. It has been a struggle for me to account for problems of language, reference, causality, and identity, which is the most haunting one. Like Smith, who faced an ontological wall, it is my belief that these deep lying problems have their roots in metaphysics.

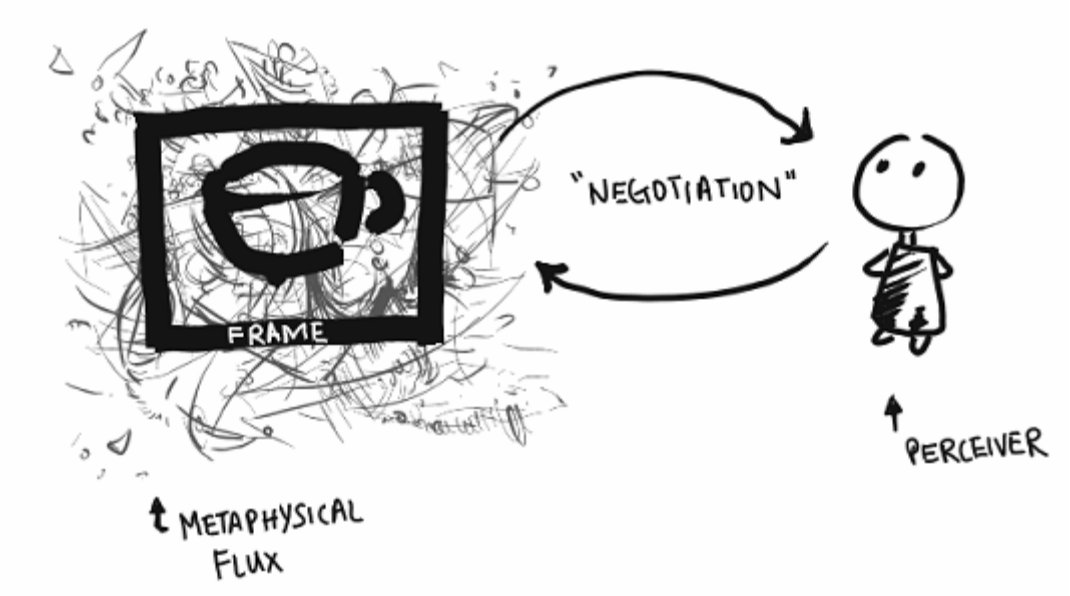
1.1 Metaphysical flux, abstraction and framing

Allow me to quickly brush aside the monsters of idealism and Matrix-esque theories. Reality does exist in an objective sense, although whether it possesses any significance without perception is not our concern. Smith conceives of reality, which includes all the objects we perceive, as metaphysical flux of which the person is a part of, and operates within. When she perceives an object, what is happening is an *abstraction* where a patch of flux is stabilized, and an aspectual side is retrieved. Smith thinks of the abstracting process as doing "violence" to the flux because the selective abstraction means its full nature is compromised, which I disagree and will talk about later.

The stink of metaphysics begins here, when I say that we cannot know the nature of the flux as-it-is. It is necessary the flux has form and is differentiated, for if the flux were homogenous, the perception of separate or distinct objects becomes a complete fabrication of the perceiver, effectively forcing us into an idealist model. So, while we can say that the flux has some sort of "form", this particular form can *only* be disclosed when a person perceives it, which is a process of selective abstraction. This means that all we have access to are "partial", organized and transformed representations of the flux. Attempts then, to describe or characterize the flux as "chaotic", "rich" or "sloppy" are something of a mistake, often failing to contribute meaningfully except as a loose analogy or as an aesthetic marker.

Now let us consider what *framing* is: an organized salience distribution window, where said level of salience is determined by an algorithmic process as to how relevant the particular entity or information is to the intention or task. A frame is necessarily an aspectual retrieval of the particular target content. While it may at first seem that abstraction does not share the same mental component, it is necessarily motivated by intentionality and a particular *direction* of thought. That is, when we abstract objects, we are *projecting* onto it. In this sense we can see how abstraction can be reasonably equated to framing, although most academic usage of framing is applied on a phenomenal level and not a metaphysical one. Regardless, I will term the perception of an object from metaphysical reality as an act of framing the flux.

We must be careful to avoid thinking that perceiving objects is solely dependent on the perceiver's framing. In fact, it is a result of, in the words of Jun Luo, a *negotiation* between the flux and the perceiver. The form of a particular patch of flux is instrumental in the perceiver's framing of it, although it has no intrinsic meaning or intention. We can think of the flux form as *pointing* the perceiver to one frame rather than another – in a way, it "constrains" the range of possible frames for the perceiver. An analogy would perhaps help communicating this point.



When I read a book, I can interpret its content in a multitude of ways but the syntactic arrangement of its words directly affect how I can interpret the book. For example, I could frame the killing of an antagonist as an act of vigilant justice but it would be difficult for me to think of it as a symbolic expression of boredom. In this case, syntax participates in semantic interpretation by simultaneously guiding and constraining possible frames, just as how the form of the flux participates in its being framed. It must be noted that the nature of the reader also affects the possible semantic interpretations, and an insistent or paranoid reader pick outs some specific semantic in *anything*. Underdetermination kicks in, and suddenly the Smurfs are a symbol of communism.

In framing the flux, the resulting perspective is then a culmination of an interaction between the form of the flux and the properties of the perceiver. That is, we can think of the perspective as being *anchored* to the flux and the perceiver.

1.2 Framing, violence and reason

The aspectual retrieval of framing means that only a particular perspective is presented. Alternate perspectives are neglected, and because a frame is a salience distribution window, some portions of the frame are accentuated and others ignored. Smith refers to this as doing *violence*, and while this is true in the technical sense of the word, I disagree with the possible implicit notion of a leakage or a loss of information. To me, framing the flux is more than just a process of limitation – it *gives* perceptual form to the flux and *realizes* them into objects in phenomenal reality.

The partial, organizational nature of the frame is simultaneously the *limit* and the *reason* for perception. In the happier days of my first year, a fellow student claimed that we were "limited" by our body because its physiological form restricted us from flying. While that is true in some sense, we cannot say that our bodies are *mere* limitations. The removal of a mere limitation would allow success in the desired task, like how removing a roadblock would allow access. However, taking away the body does *not* allow us to fly, and instead results in a complete disabling of physical functions. By virtue of its form, a human body *enables* movement as much as it *restricts* it.

In the same way, the nature of framing is such that a limited abstraction allows for the perception of figure and form from the flux. We have already noted in **1.1** that the form of the flux can only be disclosed through framing, and as such framing is not truly violent in the vulgar sense. It is of a much more holistic, balanced nature, for it takes and gives simultaneously. I do my best to avoid tautologies, but I think this one takes on a deeper meaning now: A frame is what it is by virtue of what it is not.

1.3 Physical and psychological framing

I am going to make a distinction between two aspects of framing; the physical and the psychological. Luo is critical of this division, and with good reason, but I will tread on carefully. I will say now that these two aspects of framing are *not* two types of framing, nor are they separate or independent from each other.

I differentiate the two aspects of framing by their target content and *character*. That is, the physical side of framing (which I will call "o-framing" for "object-framing") is characterized by the carving of physical objects from metaphysical flux. On the other hand, psychological framing (which I will call "s-framing" for "semantic-framing") is characterized by the semantic framing of abstract mental content. It must be noted that framing necessarily carries a mental component, since the very act of forming a salience distribution field, even if only for physical objects, involves the mental act of the sorting of relevancy. To frame something is to establish a semantic relationship with it.

Using (or maybe abusing) Smith's terminology for a simple summation of the two aspects of framing, I would say that o-framing is linked with *matter*, while s-framing is linked with *what matters*. They differ also quite significantly in their malleability, or their possible frame range. I have noted that o-framing has the form of the flux as one of its anchors, effectively constraining and guiding possible frames, and so o-framing is usually relatively stable. We do not usually have the capacity to adopt two o-frames of everyday objects like watches. This does not mean that the anchor cannot be dislodged; the influence of alcohol and psychotropic drugs can strongly alter the perceptual and mental faculties of a person, wildly affecting the o-framing process.

On the other hand, s-framing seems to naturally easily possess a larger frame range, ceteris paribus. That is, mental content can be s-framed in a multitude of ways without the influence of substances (although they do bear influence upon consumption) and this is due to underdetermination. A single event can be s-framed in a plethora of ways, more than one of which could constitute a reasonable account.

That said, it seems that the anchors involved in s-framing are much "looser" than that of o-framing. In abstracting objects out of flux, o-framing is anchored in the flux patch and the perceiver's properties, both of which are relatively stable most of the time. S-framing, in contrast, is anchored to "fuzzier" properties of the perceiver, which are the more fundamental computational processes of the mental capacity to remember and process as well as the framing tools of language, knowledge and experience.

1.4 Complete metaphysical significance

While entities experience phenomenal worlds that are essentially abstractions of the metaphysical flux, their interaction with the flux remains *wholesome*. Smith demonstrated this point brilliantly in UTISM 2006, noting that when you drink a bottle of water, you don't drink merely what you *know* of it (your frame of the water) but *all* of it. Despite only having access to only an aspectual side of the flux, the entities remain fully and intimately connected

to the flux. The entity's metaphysical *significance* is in no way diminished just because of limited retrieval. She remains an integral part of the whole that constitutes reality.

1.5 A non-absurd metaphysics

And thus my metaphysical picture is fully sketched in its first draft. The formalist would not be too pleased with the fact that the nature of the flux is unknowable, and its disclosure is necessarily a limited retrieval. However, what I think is promising is that this metaphysical account seems to be nowhere near absurd or mystical. Instead, it appears to me as a sort of reality that, while elusive to full comprehension, is quite *close* to our perspective of it. In fact, my current hunch is that metaphysical reality is really *energy*, but that would be another paper altogether.

In saying that our perspective of reality is *close* to its nature, I mean that when we perceive a cup, it *really* is there in a significant sense that corresponds to flux. It *is* a patch of flux, and while at the metaphysical level one cannot claim that the cup is "in" the flux because it is meaningless to assert so, we can say something like the cup being a disclosable form of the flux. To formulate it in another manner: the flux possesses the potential frame of the object cup, and *is* for all practical reason *your* cup.

It is then with confidence, that I can say that what I am experiencing is a perspective of *the* world. There is only one world that we operate in, and while each person possesses her own unique perspective, they are all faces of the same die.

3. The Perceiver & Metaphysical Localization

Having discussed the flux, we will now move on to talk about the other *anchor* of the perspectival relationship: the perceiver and her properties. This perspectival relationship is also her "phenomenal" world, a theory or construct of the world, which is a sort of metaphysical localization to a plane of existence.

In this section I would like to talk about two important properties of a person that participate in her framing of the world: native properties and embodiment. Although this paper is restricted to these two, this is not to say that they are the only contributing factors from the perceiver. Her knowledge and experience, of which cultural influence and particular upbringing have an influence upon, also participate in the framing process.

3.1.1 Nativism

Nativism proposes that humans are born "hard-wired" with certain attributes, of which Chomsky has argued for an embedded universal grammar and Fodor for the innateness of concepts. Our discussion will explore two native properties in innate concepts and in-born perceptual mechanisms, and I hope to be able to convincingly posit a sort of nativism in native *principles*.

When we consider how essential certain native properties like linguistic nativism and innate concepts are to a human's phenomenal and social existence, the nativist position can be construed as painting a picture of an intrinsic connection between human beings and the world in all its physical, social and mental colors; as if the world were *meant* to be humanly perceived and operated in. And herein lies the importance of this segment, to observe and analyze how these innate properties *correspond* to reality, from then which we will

appropriate tie into the sketched metaphysical picture. Some doubt may be raised about my metaphysical conception from this discussion.

3.1.2 Innate concepts

What a "concept" is remains elusive to precise definition, although the common use of the word would probably be something like the "idea" (or mental representation) of a thing which includes its relational functions. One can have a concept of a "cat", a "car", a "book" and so forth. Note that some of these concepts correspond to *post-frame* objects that exist on a phenomenal and not metaphysical level.

For example, an adult human's concept of a chair would include its functional property of "to-be-sat-on", "furniture" and such. A child might conceive of the chair as an obstruction, or even as a private space as it sits in the hollows between the legs of the chair. These concepts are *layered*, of which the layers are not innate but built by the individual's knowledge and experience. Questions are then posed: what is an innate concept, how is it innate, and is it possible that its relational functions are innate as well?

I will try to build a physical account of innate concepts. We know that humans are predisposed to being conditioned to easily fear snakes and spiders, but not flowers. This curious fact of innate stimulus discrimination suggests that humans are innately aware of the possible dangers that those creatures pose, and that information about snakes and spiders are physically transmitted from generation to generation. As such, it is plausible to suggest that the concept of a snake or spider is innate to humans in some way.

The phenomenon can perhaps be explained neurologically. Our primary visual cortex (striate cortex) possesses cortical cells that fire to certain shapes and sizes, of which fires in a certain pattern according to the particular object being perceived. That is, certain patterns of neuronal firing represent certain objects. It is not absurd then, to propose that a snake's neuronal representation is hard-wired into humans and is innately connected to the firing of fear in the amygdala. If we take the neuronal pattern to be the *concept* of snake, then it could explain to some extent the generality of a concept, because the neuronal patterns respond in varying intensities to things that *look like* the object. The concept of a snake includes many sorts of snakes that share a family resemblance in physical appearance, and this similarity is enough to generate the firing of the same pattern, albeit in differing intensities. Point being, we don't fear snakes per se but snake-like objects, which is why systematic desensitization for fear of snakes sometimes starts with plush snakes.

This physical account of concepts is somewhat unsatisfactory, because it becomes much harder to imagine a parallel case for abstract innate concepts like numbers (which I shall just presume is the case, and skip over the clogged debate). Abstract concepts do not have a physical form upon which the neuronal pattern can map onto. It is still conceivable that they *do* have a neuronal representation which fires whenever the concept is being thought of.

There is a possible alternative construal to which I think Fodorians will at least be more sympathetic. Fodor argues that relational functions of a concept are mere *concept-possessions*, which are different from the concept itself. So instead, we can conceive of the neuronal snake pattern as a mere "pointer" that facilitates one's grasp of the concept for us to build upon. But then we still have to provide for a physical account of concept to remain materialists, which now becomes as mysterious as consciousness itself.

Regardless, it seems more than plausible that there are representations of things that are innate in humans. The importance lies in their *correspondence* to the world. While some concepts seem to be of those derived on a phenomenal level like snakes and spiders, the

concept of *numbers* is much more troubling. I currently consider abstract numbers as belonging to the metaphysical realm, and being embedded with innate *metaphysical* concepts seems almost like a betrayal of physicalism. Despite how unsatisfying this must be, I cannot go further into this discussion.

What we learn from innate concepts is an implication that humans are innately wired with the concepts of *framed* objects to some degree, which possibly reflects their shared evolutionary history. More surprisingly, it seems that there are also *possibly* innate concepts from the metaphysical realm. These are shared across members of the species, and I will argue for its significance in the latter segment on metaphysical localization.

3.1.3 Innate perceptual system

The human visual cortex possesses specialized cortical cells (also called feature detectors) that respond to different stimuli. The simple cells respond to stationary stimuli, while complex cells respond to moving bars.

At a phenomenal level, one experiences movement or non-movement, of which a book is likely to fall in the latter category. So we say that the book is stationary. But physics has informed us that *everything* is constantly in motion – molecules vibrate continuously and all the molecules that compose what one demarcates as the "book" are vibrating, although we honestly perceive otherwise.

This cannot be simply waved away using an emergentist argument by saying that the property of the whole differs from that of its composite parts, e.g. water is wet but H2O molecules are not. Instead, this seems to me to be more of a problem of scope and perceptual limitation. From a distant raised cliff, I would perceive a faraway boat at a dock as being stationary but with closer inspection I would realize that it is constantly bobbing on the water, and no relevant reduction has taken place. In fact, cortical cells respond not to the world but to the electrical signals from the retina's receptors. That is, light (energy) is directed from the eye's lens upon the photoreceptors, which in turn respond to the photons (energy) to send signals to the visual cortex. The cortical cells, along with higher visual processing areas, then construct an o-frame out of these signals.

That most humans share the same in-born perceptual system allows the inference that the o-frames of human beings are at least similar. This means that, barring logical possibilities of inverted qualia and such, humans carve the world in significantly similar ways. An interesting empirical study by Marks (1974) showed that people associated lighter colors with higher pitches; red, white and yellow were rated higher and brighter in pitch than black and brown. Unfortunately, I could not find out more as to whether the group tested was a cross-culture sample, although it was likely not to be. This means that their aligned associations could be a result of culture – for example, red is auspicious for the Chinese but carries bloody connotations in Western culture. It is possible that a cross-culture sample could group the colors and sounds differently, although any within-culture alignment would remain supportive of my thesis of metaphysical localization.

3.1.4 Native principles / mechanisms

What I'd like to posit here is native principles, or native *mechanisms* that guide humans to frame situations and stimuli in the same sort of way. We can adopt a computational approach for this by thinking of native properties as coming together to form a complex algorithm that performs framing to organize and demarcate objects in the data set, physical or

mental, in a certain manner. That is, a similar set of native properties between people will encourage aligned framing of content.

This sort of claim seems unavoidably vague, and I will try to make clear my point. If we imagine framing as a sort of *filter*, then it is likely that native properties like the perceptual system contribute to the filter to o-frame a patch of flux. Given the same patch of flux, we can infer that similar native properties will frame the flux in similar ways. Scott Atran (1995) has noted how human beings across cultures have "similar folk-biological schema composed of essence-based species" which also ranked them into higher and lower order groups. He makes a further assertion that the further categorization within groups was representative of the "routine products of innate 'habits of the mind'". This is plausible evidence that indicates a native algorithm at work, although it can be undermined because our sorting mechanisms might be an external technique passed down through generations that has its origins in our history as primitive humans in Africa. Innate or not, the organizational mechanism for sorting animals seems to be similar.

The most powerful benefit that native mechanisms can offer is an explanation how humans can generate aligned concepts in face of novel stimuli. That is, when two humans are talking about "gavagai" to describe an unfamiliar creature, they are both likely to possess the concept of the entity as a whole rather than either of them having a misaligned concept of "gavagai" meaning "time-slice of said creature".

Native mechanisms thus provides a reasonable view as to how new concepts are acquired, and why two entities of the same species will likely acquire the concept in similar ways, ceteris paribus. We have not taken culture and other s-framing factors into account. Regardless, this seems much more feasible than Fodor's theory of innate concepts and his Platonic position of an embedded reality in the human mind, which means we only *discover* concepts, and not make new ones. It is one thing to think that the concept of snakes are innate, which can be reasonably accounted through our evolutionary history as creatures in the wild, but it is another to think that the concept of doors and knobs are innate.

This position need not, and it seems, *cannot* be mutually exclusive with innate concepts. There can be innate concepts *and* innate principles that build more concepts, possibly utilizing the native concepts whenever needed. I say that it cannot stand independent from innate concepts because the mechanism alone would have a very difficult time trying to explain abstract mental concepts like numbers. It is not impossible; we could still posit native mechanisms can learn metaphysical concepts but we may be increasingly far divorced from a productive, scientific conversation.

The main problem with positing native mechanisms would be empirical evidence. The two cases that I have specified, which are the color-sound experiment and the common categorization across cultures, are both explainable by culture as well. The intricacy of the current build of societies as well as our ancient shared heritage makes it difficult to produce specific pieces of evidence for native mechanisms. Fortunately, this paper only really needs the *alignment* in categorization, and is not too deeply concerned with its causal roots. This will be shown in *section 3.3*.

While native properties contribute to framing, it is conceivable that two people with identical innate properties frame identical stimuli differently because of different intentions, considerations and task at hand. As such, cultural influence can readily affect the basic motivations of s-framing. What we want to explore now is the role of embodiment in framing; in *section 3.1.2,* I talked about *layered* concepts that were built through personal experience, and a person's embodiment is often inextricable from this.

3.2.1 Embodiment

The embodiment of an entity is its physical form; for humans it includes our height, body shape, hands, and fingers and how we can utilize them. Embodiment is a powerful determinant of how entities conceive the world – if it walks it conceives of landed spaces as areas it can traverse upon, if it flies its mobile potential space is conceived in an entirely different manner with vertical spaces being more salient. Entities are necessarily embodied, and their specific embodiment determines their physical interaction with the world, which in turn heavily influences s-framing.

An entity's embodiment is one of that which builds layered concepts. By having hands and fingers capable of clasping objects, we can conceive of "grip-able" as relational functions of objects we interact with. It must be noted that this relational function is dependent on the nature of the object as well, and the relationship becomes much more obvious in modern society where we *design* objects and places with specific functional relations in mind. For example, knives are designed with handles in mind for gripping. In a way, the "syntax" of everyday objects *significantly* points us to one sort of frame rather than the other. Our interaction with the objects, depending on our embodiment, then significantly affects its s-frame.

This is not to say that an entity can only form s-frames of objects that include direct relational functions to it. A handicapped person without hands can still hold a concept of door handles as a device to be gripped, because her interaction with it includes observations as to how others utilize it. While the handicapped person's concept of the door handle is more or less aligned with that of an average person, it is not the case that her *relationship* with the door handle is as similar. I have argued in *section 2.3* that to frame something is to have a semantic relationship with it. In this case, her semantic relationship, or s-frame of the door is quite different from that of others. The door handle *means* something different to her from the average person.

3.2.2 Micro-scale vs. macro-scale

I would like to further distinguish differences in embodiment at the micro and macro scale. In general, embodiment differences between-species are macro-scale differences, as is that between a rat and a human. Within-species differences are what I call micro-scale differences. I must note that these differences are in degrees; for the apes share much similarities with humans, as cats can be construed so with dogs. The terminology will remain useful in our discussion.

The micro-scale effects of embodiment permeate humans in our daily lives. Each individual's specific embodiment prompts different s-frames of the world; with the most obvious example being shopping for clothing. We look for those specific to our size, and those whose embodiment are significantly different often have to venture to specific places to purchase their clothing. Very tall people conceive of spaces differently as well, especially when they have to lower their heads when walking through doors, while smaller people might find weaving through crowds a simple task.

It is not the case that differences in framing are solely due to embodiment. As I have said, much of our everyday lives revolves around a *designed* world, tailored especially for the majority. As such, the differences in framing are *accentuated*. We need only consider how most of the world is created with right-handers and fully physically functional people in mind

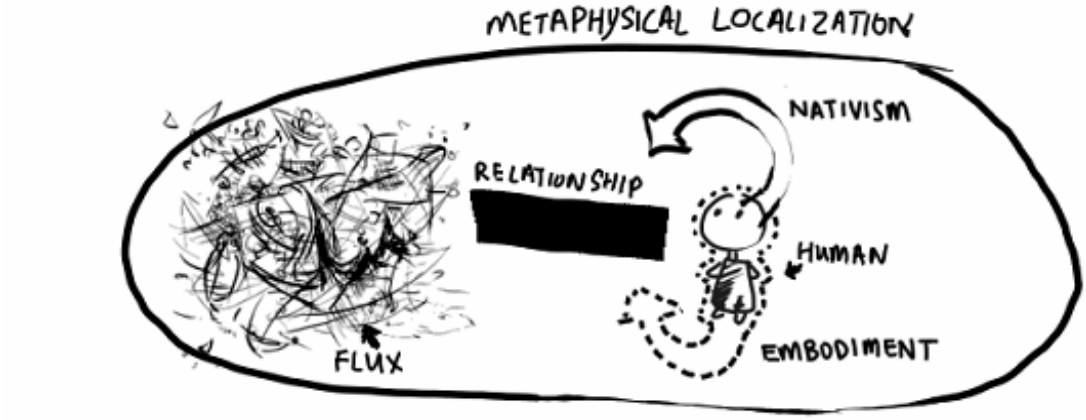
to know that. Left-handers trying to play the guitar will no doubt conceive of it differently, and the physically disabled will find traveling to certain places particularly challenging.

The macro-scale differences affect s-framing in a more fundamental way. For example, humans often find heights exceeding twice or thrice their physical height dangerous, but cats probably have no problem with that at all. If we could regenerate our limbs like starfish can, our s-frame and daily activities would probably change significantly. It must once again be noted that the participation of the environment is important in s-framing. Animals thrust into our designed world would find it incredibly frustrating with transparent glass walls and doors that need to be opened.

I conclude this segment by arguing that micro-scale differences shared between humans provide smaller s-framing differences than that of micro-scale differences. Humans share similar s-frames of the world by large. However, it must be noted that the design of our environment accentuates the micro-scale differences.

3.3.1 Metaphysical localization

The previous two sections on nativism and embodiment now culminate in their synthesis here. I will argue that the relationship between perceiver and flux, which both innate properties and embodiment participates in, carves out a phenomenal world for the perceiver which metaphysically localizes her to a "plane" of existence. This plane is shared between her and other entities that bear the same relationship with the flux, from which I will draw the conclusion that human beings as a species are metaphysically localized to the same sort of existence.



In the illustration above we have our familiar human figure, and I have denoted the thick black band as her relationship with the flux, which both the form of the flux and the perceiver's properties participate in. The important addition is the ellipse I have drawn encapsulating all of it, representing the particular frame of world generated.

It must be noted that nativist properties and embodiment work hand-in-hand in the perceiver's framing of the world. Their relationship is intricate; when one grips an object and interacts with them, native mechanisms kick in to build the layered concept and in consequence, the perceiver's world-view. Human beings are, by virtue of their similarity as well as their designed environment, localized to a frame of the world different from that of other creatures. Make no mistake; there is only *one* world that humans, animals and objects share and operate in. But by framing the world in similar ways, humans share the world more *meaningfully*.

The shared properties between humans result in obvious behavioral similarities. Across cultures all humans take the care to protect themselves from damage, utilize objects as furniture and tools, interact and communicate with others and so forth. Within cultures the similarities are much more obvious, and the differences accentuated as well. While humans don't share the exact same perspective of the world, it seems to be the general case that the more similar the perspectives are, the more meaningfully humans can share the world.

This is particularly significant because I do think that sharing the same frame of reality greatly facilitates meaningful communication between humans without always falling to the pits of radical translation. When two people talk about someone, say, Paul Churchland, they both know that they are referring to the entity and not anything else (unless you are John Vervaeke). Of course, there is no *guarantee* that they are referring to the same object since the bridges of similarity provide only that of increased communicatory success probability. Even hyper-micro-scale differences lead to failures in communication, especially when arguments get *very* particular and one's inaccessibility of the other person's frame leads to misunderstanding.

The sort of misunderstanding arising from micro-scale differences, though, seems to be a feature made possible from macro-scale similarities. That is, the miscommunication is still conducted more or less in the same "plane" of existence. We can still talk past each other, like the proverbial battle between the walrus and the elephant that never meet on the same ground, but having someone miss your point is significantly different from having say, a *cow* miss your point.

I will also say that culture and upbringing play a critical role in metaphysical localization, because they are major factors in determining one's s-frame. This is why people of different "classes" or "niche" in society find themselves quite removed from each other. A working class middle-aged male would find the young hippie quite an alien. It is possible, that given enough differences in s-framing, two people can find themselves localized in significantly different frames of the world. As a side note, it seems that this difference often breeds hostility when the s-frame is particularly rigid.

3.3.2 Understanding developmental windows

In the context of metaphysical localization, it becomes interesting to examine the developmental windows of human beings. For one, native properties usually have critical periods in which they have to be developed, or its function will be severely impaired. Binocular sight is one such example, and language is another one. Our embodiment is also affected by maturation, and puberty can be conceived as its developmental window. In arguing that nativism and embodiment are influential participants in one's relationship with the flux, and that the resulting frame is a metaphysical localization, these critical periods can then be construed as a sort of metaphysical "tuning" process. Sharing the world meaningfully means to be metaphysically in tune.

Metaphysical tuning does not only happen during critical periods because constant changes in the perceiver's properties, whether physically or mentally, mean that she is constantly being tuned to some specific frame or another. However, the critical periods are particularly important in that the tuning rate is much faster than other periods in life, and more importantly that improper neglect during these periods will lead to a severe impairment of the particular function. This often completely destroys the opportunity to tune to that window, and significantly affects metaphysical localization.

The idea of tuning also brings us back to our discussion on anchors in *section 2.3*. The critical windows of physical development happen intensely often in early life, while mental development does not necessarily follow such a rigid pattern (save linguistic nativism and other possible basic functions). My assertion that s-framing relies on "fuzzy" anchors is reflected in the fact that mental development and change occurs throughout one's life with a varying possibility of intensities that physical development does not possess. Although our common folk theory is that people have relatively "settled" beliefs and ideologies by forty, it does not seem to be necessary, whereas physical development cannot say the same.

So now we can perhaps think of ourselves as string instruments, strung and innately tuned to the same general frequency to compose the symphony of human reality. Just like real orchestras, we tune differently according to the acoustics of the particular hall that we practice in, and when we play in private with individuals we seek to tune to a common frequency whereupon music can be built. This, I think, is more than a romantic analogy. When we are in the familiar presence of a friend, we shift into a particular sort of behavior and frame that we are accustomed to. In getting to know someone, we put the effort to find common ground to get a conversation going.

3.3.3 Metaphysical localization & fixation

This final segment on localization concerns itself with such – *over*-sharing the world, if that even makes sense. By this I mean to explore the payoff relationship between the extent of sharing a frame and the framing effect of fixation.

If two people were metaphysically localized to a frame of incredible similarity, I imagine their interaction could be very pleasing and each might think of the other as a soul-mate. But this is not without a cost – it is unlikely that either of them will learn anything *new* or different. That is, they become fixated in a frame and stagnate.

That is, creativity and new ideas to solve problems are features of framing differences. As a Zen saying goes: "Only when the chain is broken, can you let in new light." It is necessary that humans share different particular frames of reality, so we can continually learn and progress from others. But a balancing game must be played; significant differences in frame might lead to a communication breakdown, while significant similarities could lead to stagnation and dead-ends.

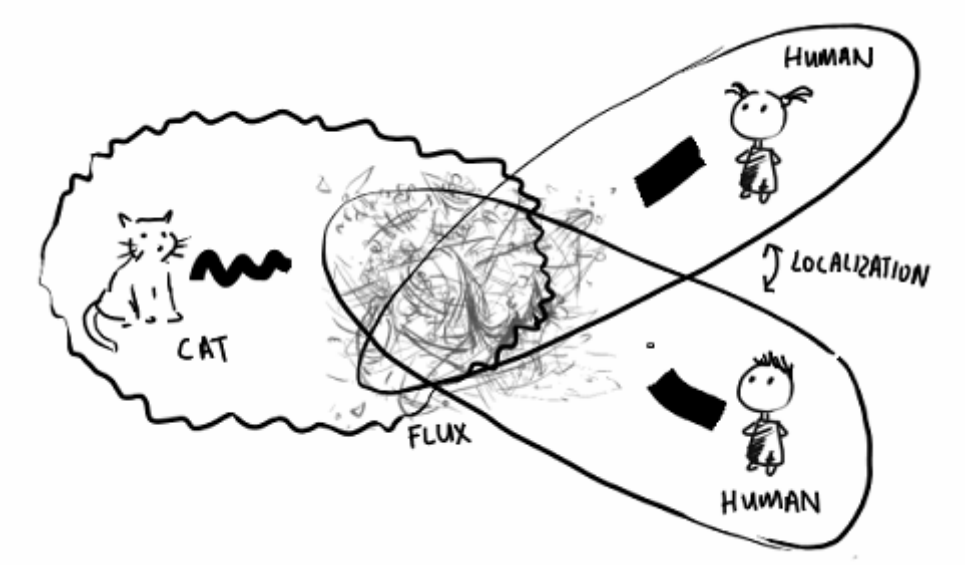
4. Sharing Worlds and A.I.

This final section will intimately combine the metaphysics and its localizations, and use it in particular to reframe the project of Artificial Intelligence. I have, outside this paper, thought of the project of creating a conscious A.I. as really a project of A.H. (Artificial Humans), where what we are trying is to implement human beings into silicon chips. After all, why are we trying so hard to make an entity embodied into our same physical form, or one that can pass the Turing test (or its "Total variation)?

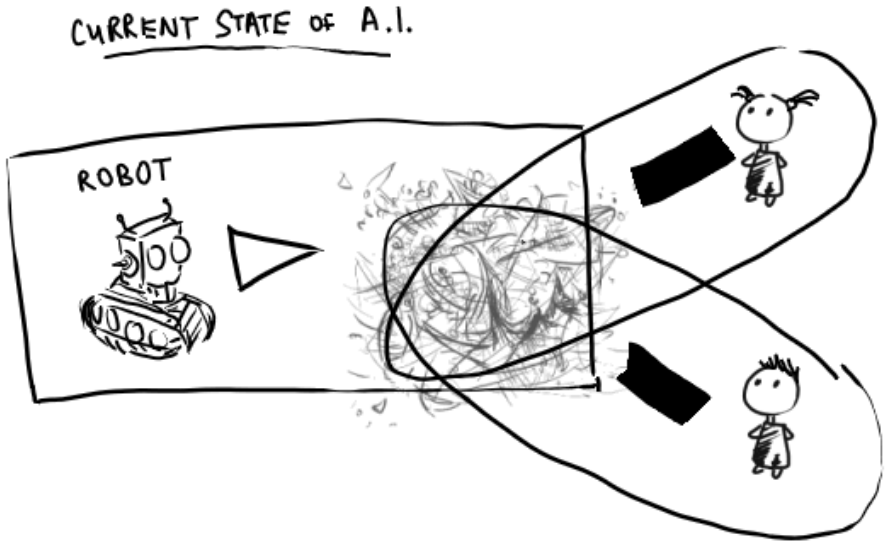
The writing of this paper has made me realize that A.I. is more than that. What we are really trying to do, is to create entities that are metaphysically localized to the same frame of the world that we are. Only through that can we find them meaningful and relevant, as they share an intelligible frame of the world that we can understand. A.I., is about reaching out to make entities share the world, the same way.

4.1 To share

The illustration below demonstrates the similarities and differences in frame between entities. I have put in a cat that has a wavy band constituting its relationship with the flux instead, generating a jaggy frame. The two humans, in contrast, share very similar frames of the world, and this occurrence metaphysically localizes them to the same plane of existence.



The crux of the issue with A.I. then, lies with what frame of the world we are allowing them to have. I have to note a possible sore point before continuing. One might think that we have to generate conscious robots before embedding them with framing capacities, but Smith thinks otherwise. For him, the very definition of being conscious *is* to have a phenomenal perspective of the world. That is, to be able to frame is to be conscious. This is fairly controversial, although I am somewhat partial to Smith's view. Regardless, the consciousness issue has to be waved aside for me to continue.

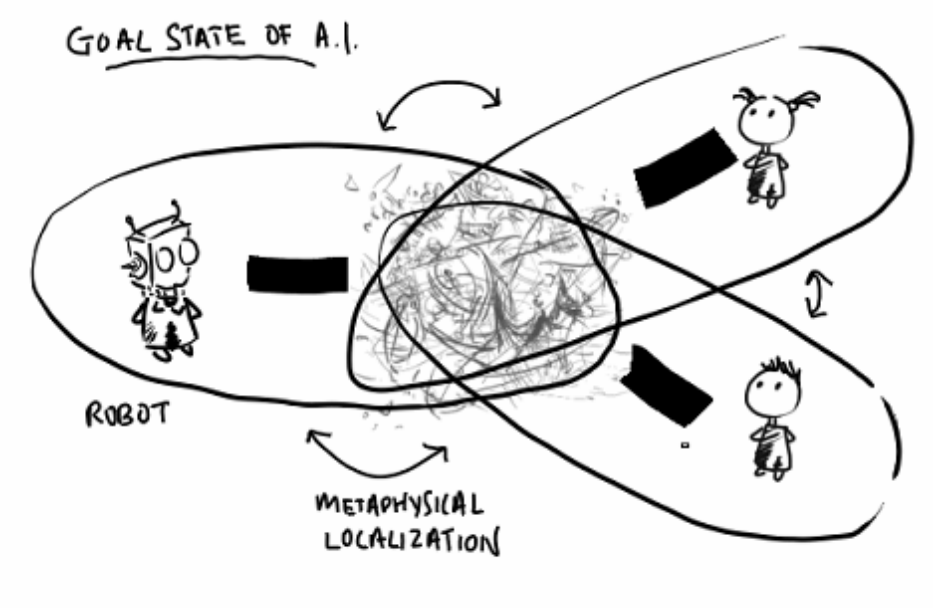


The current state of A.I. is still far from achieving anything remotely capable of s-framing, although o-framing has been achieved to a minor degree. That is, the lack of a semantic relationship with the world means that the robots of modern day share only superficial relationship with the flux. GOFAI and its formalistic symbolic manipulation also results in rigidity in the robot's incomplete frame of the world.

Current forms of robots also remain rather primitive in their form of embodiment, and by that I mean embodiment in a real, fluid, functional sense rather than just decorative make-up. We could shell a poor A.I. in a supreme human body replica, but it is just not embedded to its form for us to think of it as having any significance. The level of control current robots have over their body parts are still rather limited, and the information they can retrieve from its interaction with the world is also very meager.

To this day, no computer has satisfactorily passed the Turing test, although "parrot" models like ELIZA may achieve initial success for the layman judge. But it is curious that the Turing test remains a benchmark test for many A.I. engineers. It measures only specific linguistic competence of the judged, and more importantly, it is measured *relative* to the judger. The layman and the philosopher as a judge of the same Turing test will have quite different criteria. The beauty of the Turing test lies in its elegance as a threshold test, where as long as behavior is indistinguishable from a human subject, it is considered to be intelligent. And yet this is not quite true, because one of many major flaws in current A.I. is the inability to catch jokes. While we frame this as an error or deficiency for robots, we often see this as a trait for human beings.

So, our goal is roughly that of building a robot which possesses a relationship to the world similar to that of a regular person's. What we want are robots that are fellows on the same metaphysical plane.



4.2 Implications: Epistemic Boundedness & Multiple Embodiment

There are two important implications in framing A.I. as a project of metaphysical localization, and it is deeply related to epistemic boundedness.

The attempt to create entities local to our frame presents something of a worry – are we possibly rejecting viable, alternate forms of intelligence? Or can I really say that at all, since the only intelligence that I can understand is that of human beings. The issue is that it is both logically, and metaphysically possible that entities can frame the flux vastly differently from humans, and display behavior humans might conceive as entirely non-intelligent despite possessing a meaningful relationship with the flux.

However, if what is "meaningful" is not out there as an intrinsic property of the world, but rather the product of my semantic relationship in framing the world, then I can judge what is meaningful *only* through the frame that I have access to. This brings us back to the *necessarily* aspectual retrieval of framing, and our being localized to this frame allows for meaningful communication with similar frames which gets increasingly less meaningful as the differences become exaggerated.

It seems then, that epistemic boundedness is a necessary feature of framing. This does not necessarily spell doom, because if intelligence is an intrinsic feature of the world, then we might be able to discover the general "principles" of intelligence. Honestly, I have no idea what that means or entails, but *my* cognitive limit does not rule out its possibility. However, it seems that while talking about the *possibility* of alternate intelligence can be purposeful, talking about the possible *forms* they might take on is really not a productive venture for now.

Another concern is that of multiple embodiment. The intricate link between nativism, embodiment and metaphysical localization could possibly limit the range of possible structures of minds. It is not clear whether a silicon based robot will operate as we do in the environment, because its parts are so replaceable. Our evolutionary history has decreed both the "survival instinct" and sexual desires as very basic motivators to our behavior. Our robots would have to possess both of these to possess similar frames of the world as we do, but we currently conceive of robots being replaceable and replicable, and sexual robots would be, to say the least, rather interesting. As a result, it seems possible that only humanoids will be meaningful or intelligent to us.

This appears quite absurd prima facie, because it seems quite possible to design giant spider robots that behave intelligently in our environment. The key is whether the nature of their embodiment would allow them to conceive the world in a way that allows humans to have meaningful interaction with them. Numerous crazy possibilities now present themselves; perhaps we could "incubate" baby A.I.s into humanoids as their development window to form a humanly semantic frame, and then later port them into spider robots. I shall not continue, despite it being quite entertaining.

We learn two things from this, and both result from the nature of framing. What we can make out as intelligible is limited to our frame, and what we can make as intelligible to us is possibly limited in their form as well. Unless the general principles of intelligence are discovered, our frame presents limited future possibilities.

5. Final Words: Sharing the World

As one deeply concerned with the meta-pictures of reality and meaning, I cannot help if my concluding words are more than a little romantic. What then, does it mean to share the world in a meaningful sense? It really is about seeing the world in similar ways, *and* being able to communicate and interact with others through this similarity. A loose parallel presents itself in Antoine Saint de Exupery's words: "Life has taught us that love does not consist in

gazing at each other but in looking outward in the same direction." But let us make no mistake; the fact that our particular perspective is unique means that one will never find another exactly like oneself. And more often than not, we are thrown into a sea of differing perspectives, of which simultaneously moves and disgusts us.

There will always be an unbridgeable existential gap, but only the deluded look for a perfect mirror image of themselves. And in that way, they seek only to have someone possess the *same* world as they do. The beauty of communication is a genuine, honest transfer of intentions between unique beings. And that, is what constitutes *sharing the world.*

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Early Diagnosis for Autism in Infants

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1. Introduction

In America today, roughly 147,867 people are diagnosed with Autism. Since one out of every 2000 people is diagnosed with some degree of Autism Spectrum Disorder (ASD), it is an important disorder to research and understand in order to identify autism at an earlier age and to possibly create necessary environmental changes to counter the onset of developmental delay. In this paper, the biological and environmental aspects of ASD will be discussed in relation to the potential for early diagnosis and intervention of autism in infants. Previous research on family and sibling studies will be used to examine the biological basis for ASD while Applied Behavioral Analysis will be discussed to examine how treatment and changing the at-risk infant's environment can improve his or her development.

2. Genetics

The link between genetics and diagnosis of Autism has been clearly established through family and sibling studies that analyze heredity in diagnosis of ASD. Bespalova and Buxbaum (2003) attribute the predisposition to have autism to be at least 90% genetic as seen through twin, family, and sibling studies. Since Autism is so highly genetic, parents who have one autistic child are five percent more likely to have another autistic child, and much more likely to have a second autistic child if the older sibling is a girl. This is because the male to female ratio of being diagnosed with ASD is four to one (Bespalova & Buxbaum, 2003).

As Rutter (2000) discusses, these genetic findings are important for a variety of reasons. First of all, they focus the root of autism on neurodevelopment rather than attributing Autism to poor parenting as previously assumed. Also, further genetic research could result in finding protective factors for females to see why males are more inclined to be autistic. Additionally, the genetic component of Autism is important because researchers and doctors can focus on identifying a phenotype to help intervene when children show at-risk behavior.

Since the younger siblings of autistic children are at higher risk for developing autism, sibling studies have been conducted to try and isolate characteristics that could lead to early diagnosis of autism. Furthermore, since overt symptoms of Autism do not fully manifest until the child is two or three years old, an infant diagnosis could result in earlier treatment the potential to counter the at-risk child's developmental delay. Two recent studies that focus on younger siblings of autistic children who are at risk for developing autism (Sib-ASD) and younger siblings of typically developing children (Sib-TD) will be examined.

3. Sibling Studies

The first study, conducted by Yirmiya, Gamliel, Pilowsky, Feldman, Baron-Cohen, and Sigman in 2006, compares Sib-ASD and Sib-TD at 4 and 14 months of age on a variety of social and language tasks. At four months, twenty-one infants (8 girls, 13 boys) were observed and coded for mother-infant interaction during free play, infant attention and reaction to the "still face" paradigm, and the infant's reaction to the mother calling his or her name. The Sib-ASD infants were matched with paired controls that accounted for gender, age, birth order, sex of older sibling, and mental and motor scores. Later, at fourteen months, thirty babies (11 girls, 19 boys) were evaluated for verbal and nonverbal communication and cognition. These babies were also matched with paired controls from the Sib-TD group.

Although most of the results were the same for both groups, Yirmiya et al. (2006) identified discrepancies in early social engagement that might have contributed to differences in communicative and cognitive skills at 14 months. The Sib-ASD group was more neutral to the still face and was much less upset than the Sib-TD group (Yirmiya et al., 2006). This could imply that the infants at risk for autism had already developed an aversion to faces and social interaction so they were less likely to be disturbed by the experimenter's still face. Later, at fourteen months, the Sib-ASD group had significantly fewer nonverbal gestures and had a lower language score on the Bayley scale (Yirmiya et al., 2006). While this is an important finding that could indicate potential language developmental difficulties, this group mean was primarily lowered by six Sib-ASD infants who showed a five month language delay. A surprise result was that more Sib-ASD infants responded to the mothers calling their names than the typically developing babies (Yirmiya et al., 2006). Although one would expect the Sib-TD group to orient to their names more, these children may have been more engaged in the task or play at hand when their names were called while the Sib-ASD were not fully engaged and easily distracted.

The results from the study conducted by Yirmiya et al. (2006) showed attention and reaction differences in the Sib-ASD infants and the Sib-TD infants as young as 4 months of age that were heightened by 14 months of age, as seen through Bayley's scale. This research is important, as it has the potential to help predict the onset of Autism by observing the infant's inherited genes and allowing for possible environmental changes to compensate not only for having an autistic sibling and the parenting struggles involved with raising an autistic child, but also the higher genetic likelihood of the sibling becoming autistic.

The second sibling study to look at infants who were high risk for developing autism was conducted by Noland, Stone, Walden, Sheridan, and Reznick in 2006. Since children with autism have lower scores for working memory and social awareness, Noland et al. (2006) tested younger siblings of autistic children to try and discover early behavioral risk markers for autism. Infant siblings of autistic children and siblings of typically developing children were analyzed for their looking response for a social (person) and non social event (toy) with a modified peek-a-boo game that tests working memory.

First, fifteen pairs of Sib-ASD and Sib-TD between the ages of six and nine months were matched for gender and age. A modified peek-a-boo game was then conducted and coded for the infant's "target looks" back to where the stimulus (toy or face) had last appeared (Noland et al., 2006). To have correct "target looks," the infant would have to be engaged enough in the game to remember the last emergent point after having a light and a bell as a brief distraction.

After the data were analyzed, significant differences in the Sib-ASD and Sib-TD groups were found. Sib-ASD infants had more correct target looks during the non social trial with the toy than the Sib-TD infants (Noland et al., 2006). In the social trial, however, Sib-TD infants had more correct looks than Sib-ASD (Noland et al., 2006). Therefore, the Sib-ASD group is not only looking at the social stimuli less than the Sib-TD, but is also much more in-tune to tracking and predicting the location for the non-social object than the Sib-TD infants. These results can support the case that infants at risk for autism have tendencies to avoid social stimuli and prefer non-social interaction at as young as six and nine months. Biological theories apply to the study of autism because, even in infancy, there are risks for autism that are apparent long before diagnosis for Autistic Spectrum Disorder can occur, but identifying these early signs in at risk infants can lead to early intervention.

Environment

Although the onset of Autism is greatly determined by genetics and biology, changing the environment in which the at-risk infant lives can potentially reduce the severity of the child's ASD. In a study by Lauritsen, Pedersen and Mortensen (2005), the genetic background of autism was analyzed in light of the children's social/familial environments. 943,664 children were followed from age ten to seventeen to study risk factors of the 818 children who went on to develop autism (Lauritsen et al., 2005). Risk factors of importance included the location the child and his or her parents were born, the parental age and ethnicity, and the family's history of psychiatric disorders.

While the highest risks were associated with genetics either by having an autistic sibling or with having a mother who was diagnosed with a psychiatric disorder, environmental risks were notable as well. Lauritsen et al. (2005) found a significant link between urbanization and older paternal age with autism as well as having a risk of 1.4 if the mother was born in another country. All of these risks could contribute to a less engaging home environment for the child.

The parental stresses associated with having an autistic child could lead them to react more distantly with a less interactive relationship with the sibling. This could compound the genetic influences on siblings of autistic children to almost encourage autistic tendencies of withdrawal and lack of communication. Similarly, if a mother has a disorder such as depression, then rather than encourage pro-social behavior she might encourage withdrawal in this case as well. The next risk, urbanization, could result in parents working during the day and might also provide fewer safe opportunities for the child to explore his or her environment. Additionally a sense of community and cohesiveness is generally attributed to a small town while independence and self-sufficiency attributed to largely urban areas. The final two risks identified by Lauritsen, Pedersen and Mortensen (2006) of older parental age and having a mother who was born outside the country could contribute to lesser communication between the parent-child dyad. An older father might not be as involved in childrearing and a mother from a foreign country might have language barriers to overcome which could be a disadvantage to the child's language development. Although the greatest risk for autism is genetic, the theory of environmental influences greatly applies since the environment can significantly impact the child and his or her diagnosis of Autism Spectrum Disorder.

4. Applied Behavioral Analysis

Applied Behavioral Analysis is relevant to infant diagnosis of autism because the purpose of identifying autism in infancy is to try and adapt the environment to help improve the child's development. In a study by Smith, Eikeseth, Klevstrand and Lovaas (1997), Applied Behavioral Analysis resulted in increased IQ score and increased language development of autistic children. Smith et al. (1997) compared eleven children diagnosed with either autism or mental retardation to a comparison group of ten children. All of the children were younger than 46 months old with had an initial IQ under 35 and there were no significant differences between the groups. The experimental group received thirty hours of one-on-one treatment over the course of the next two years while the comparison group had minimal treatment.
At the conclusion of the study, the experimental group yielded an increase in IQ with a standard deviation of 13.14. The comparison group, on the other hand had an overall decrease in IQ (Smith et al., 1997). Additionally, the experimental group saw significant strides in increased language and communication after extensive treatment (Smith et al., 1997). The importance of this study is that is shows the effect that extensive treatment can have on helping control autistic characteristics and how deliberately changing a child's environment can lead to positive developmental outcomes.

5. Application and Conclusion

Genetic theories and twin studies shed light to help determine causes of autism while environmental theories and Applied Behavioral Analysis are useful to be proactive in intervening to help improve social and language development. Diagnosis of autism and environmental and behavioral intervention in infants is important and applicable in our society. In the American public education system children are attending public school as young as three years of age. It is important for these schools to have significant knowledge about genetic and environmental influences on Autistic Spectrum Disorder, especially in "identifying patterns of strengths and weaknesses that can be used in tailoring behavioral goals and designing developmentally appropriate interventions for very young children" (Stone, 1999, p.188). With continued research infants at risk for developing autism could potentially undergo extensive treatment and be spared the developmental delays associated with Autistic Spectrum Disorder.

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