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**These research papers are written by undergraduate students as part of the capstone requirement for the Cognitive Science major.**
Mismatch Driven Encoding
Alexandra Loessberg-Zahl

The human hippocampus is responsible for both memory encoding and retrieval, but how it achieves both of these functions is not fully understood. Previous research posits that area CA3 of the human hippocampus is important for prediction based on past experiences. It sends this predictive information to area CA1, where it is then compared to the current perceptual reality, before CA1 makes a judgement about whether the reality matches this prediction. As of yet, there has been no data collected on the role of this mismatch signal on an individual’s memory of the mismatched information. In order to explore this possibility, the current study hypothesizes that memory will be improved for items that do not match expectations based in prior experience, presumably due to a release of dopamine back into the hippocampus when this mismatch is detected. The current study builds off of prior research by using the knowledge that CA1 is responsible for match/mismatch detection and investigating whether it also facilitates encoding when it encounters a mismatch, therefore improving memory of the mismatched item.

Over the time I have worked on this project, the design has changed several times. At the end of last quarter, the design was as follows: Participants were presented with sequences of four images and asked to make judgements about them (e.g., “How many images are larger the image that preceded it?”) to improve incidental encoding. After this learning phase, where each sequence was presented three times, subjects moved on to the mismatch learning phase. In this phase, participants were again asked to make judgements about sequences. Each sequence was either a) presented again, in exactly the same order as it was presented in the learning phase, b) seen as a mismatch version, where either the third or fourth item was replaced with a novel item,
or c) shown a scrambled version, which included three reordered items of a learned sequence and an additional novel item, placed in either the third or fourth position. The mismatch sequences would be expected to stimulate a mismatch signal in the hippocampus, as the novel item violated the previously learned order of these items. It was expected that the mismatch sequences would benefit from a greater mismatch signal than the scrambled sequences, since participants should have formed an expectation of what item will come after the first two items—which are in a familiar, learned order—and therefore the novel item would be quite jarring. However, in the scrambled sequence, the items are somewhat familiar but they are not presented in a recognizable order and thus participants should not be able to create a strong prediction of what will come next. So when the novel item appears, it will not elicit nearly as strong of a mismatch signal. In the test phase, the following day, participants see four different pictures of the items learned in the first two phases. They are asked to identify, with keyboard presses, which of the images is the one they had seen the day before. However, in this design, the prediction that novel items from mismatch sequences would be better recalled than novel items from scrambled sequences did not reach significance.

This quarter, we explored three new designs. In the first design, changes were made to the learning phase such that, rather than presenting all sequences three times, half of the sequences were presented four times and the other half were only presented once. The mismatch phase was largely the same, in that sequences from both the four iteration group and one iteration group were presented either in a mismatch condition with a novel item or in a scramble condition with a novel item. This time, only the last item in either the mismatch or scrambled sequence was replaced with a novel item. For this design, it was predicted that novel items inserted in the mismatched version of sequences presented four times in the learning phase would be better
recalled than all of the other conditions (4xScramble, 1xMismatch, 1xScramble) but particularly better recalled than its scramble counterpart. After learning one particular order of items four times, it should be very unexpected to see a novel item at the end of the sequence. In the scrambled version, as with the previous design, since the order is novel, participants should not experience the same expectation they would when the items are presented in a familiar order before the novel item. In sequences that were only presented once, the sequence has not been learned as well, so the expectation should not be as strong in the mismatch condition prior to the novel item.

However, these predicted results were not found after running 26 subjects. Results for this design did not reach significance, and the only numbers trending slightly toward significance showed a small advantage in recall of novel items in the mismatch condition—over the scramble condition—of sequences only presented once in the learning phase. This is surprising since, in theory, these sequences are not learned nearly as well as those presented four times in the learning phase, and therefore should have built up much less expectation and lead to lower recall than novel mismatch items in the sequences presented four times. It is promising, however, that, at least within the single presentation sequences, the mismatched novel item was better recalled over the scrambled novel item, supporting the theory that the mismatched sequences build expectation, and therefore unexpectedness and better recall when the novel item appears, in a way that scrambled sequences do not.

The next design we implemented this quarter returned to the earlier learning phase where all sequences were presented three times. This time, however, each sequence contained five items, rather than four, in the hopes of further increasing the strength of participants’ expectation
of which item should come next. When a participant sees three or four items in an order they are familiar with, this should strengthen their prediction that the next item will conform to this learned order as well, thus creating a more jarring feeling of mismatch when the item they see does not fit this expectation. In this design, either the fourth or fifth item was replaced by a novel item in the mismatch/scramble phase. An additional change was made to this phase such that, rather than again making relative judgements between items (e.g., “How many images are made of the same material/stuff as the image that preceded it?”) and providing an answer at the end of the sequence, participants were simply asked to make a judgement about individual items, namely, “Is this item smaller than a shoebox?” This change ensured that novel items appearing in the fourth position did not receive more attention than those appearing in the fifth position. In the previous design, where each item is compared to the one before it, the second-to-last item would be involved in two comparisons—first when the second-to-last item is compared to the one before it, and again when the last item is compared to the second-to-last item—while the last item is only involved in one comparison. So because that additional attention could affect how well recalled that item would be, this design eliminates comparisons between items.

This design was run on 11 participants and, unfortunately, its results did not reach or trend toward significance. There was no difference in recall of novel mismatch items or novel scramble items and, if anything, novel items in scrambled sequences were recalled slightly better than those in mismatched sequences.

The final design of this study we ran this quarter probably differed the most from prior versions of this research. We returned to four item sequences, rather than five, again presenting each sequence three times during the learning period in three randomized blocks. However,
rather than having participants respond at the end of the sequence with how many times the specified relationship was met, they were asked to respond (Y/N) if the relationship was met after each item. No judgment was made after the first item, as there was not yet anything to compare it to, but participants were prompted for judgments after the second, third, and fourth items in each sequence. Again, in the mismatch phase, sequences were presented in either a mismatch order, where the order is the same but the last item is novel, or in a scramble order, where the first three items are scrambled and the last item is novel. The change to the learning phase was made in the hopes of further increasing the strength of participants’ expectation in the mismatch phase. Participants would not only become familiar with the order of the images, but also with the order of the judgements. So if the sequence were house, pencil, dog, bear, and the judgment was “larger” then a participant would get used to seeing this sequence of items and get used to responding: no, yes, yes. In the mismatch phase, when the last item is replaced with a novel image—say, a mouse—participants’ expectation would be violated by not only the new image but also by the change in judgment, since the correct responses would now be: no, yes, no. Hopefully this two-fold violation in expectation will be sufficient to show the predicted results, which are the same as many of the previous versions of this study: that novel items that violate expectation in mismatch sequences will be better recalled at test than their counterparts in scramble sequences.

If, after running more participants through this current design, this effect is still not found, we may go on to increase or decrease the time between the learning/mismatch phases and the test phase, to see if the proposed mechanism for this effect—the release of dopamine back into the hippocampus—needs more or less time to become effective. All of these changes have been very eye opening for me in terms of getting to experience the kind of creative thinking that
goes into research to correct and refine methods that may be getting in the way of finding real, important effects.
Online Testing: A Discussion

Allison Nguyen

The Internet has been around for only a short while, but already in that time has become one of the most valuable tools for participant recruitment and data collection in the field of psychology. With the Internet, we are able to reach large numbers of participants with diverse backgrounds quickly and easily, and often at a lower cost than in person recruiting.

One such popular recruitment site is Mechanical Turk (MTurk), a website that pays people in exchange for tasks such as surveys or transcription. MTurk is able to recruit workers from all around the world, and they are screened before being allowed to complete tasks. The pay is generally very low for these tasks, which begs the question: Why would anyone use MTurk? The surprising answer is that most MTurk users enjoy it. When asked why they were on MTurk, the most common response was “Enjoy doing interesting tasks” (Buhrmester, Kwang, & Gosling, 2011). Some other reasons were “to pass time”, and “to have fun”, and last on the list were “to make money” and “gain self-knowledge”. There are certain workers, “superTurks”, that are efficient at moneymaking, but because psych studies are generally known to have small payouts, it is likely that they avoid such studies. The average age of MTurk workers is 31.6, and there’s an even mix of males and females on the site, making it a fairly good pool of participants.

However, there are several questions to be answered about Internet testing. Because we are not physically monitoring them, we do not know how seriously they are taking it, if they’re following instructions, and so on and so forth. With all these questions about participants, can we really trust the results we see?
The answer appears to be yes. Web data seems to match very closely to data collected in lab in correlational studies and that there are significant advantages to collecting data on the Web(Krantz & Dalal, 2000). The idea of the Internet user as a stereotypically socially misaligned white man in his early 20s is clearly inaccurate. Participant pools from Internet studies tend to be more diverse in some domains than in-lab participants (who are oftentimes university students) and just as well adjusted (Gosling, et. al., 2004). Not only that, but because the internet provides means for motivation, such as personality results or other interesting feedback, motivation is not a problem among Internet participants. However, there are challenges to online testing that need to be addressed.

Some experimental studies have also been done on the validity of Web-based studies, where Web results are compared to the results collected in lab. Fallon and Rozin (1985) compared means from Internet samples and in-lab samples when doing a study on body type preferences and found that the results were incredibly similar across groups. Between the two conditions of their study (front view and side view of human figures), they found that the Internet means and the in-lab means had correlations of .96 and .96 respectively (Fallon & Rozin, 1985). These high correlation rates very strongly point to there being almost no difference between the two groups, which is good for studies being carried out on the web. Other studies that have been done both in-lab and online had similar findings. One notable one is Allen (1996), who examined the role of shadows in distortion of depth perception. There were two experiments, one in-lab and one online. The online condition actually offered more control over the experiment, because when photographs were used, participants could not change their viewpoints, as they could in lab. Allen found that both groups were susceptible to the same manipulations of shadows, and demonstrated nearly identical results, suggesting that using photographs online is just as good as lab set-ups and
that there is no issue with using online participant pools, results-wise. This does not mean there are no problems with Internet data collection, or that researchers cannot somehow overcome them.

One of the problems with online participant pools is the anonymity of the Internet. Because participants are asked to self-report tasks and self-monitor it is possible that they will lie about themselves or perhaps not pay as much attention to the task as they would in a lab setting. This is a highly valid concern, as many people multi-task on the Internet in their day-to-day life, and might see nothing wrong with doing so while participating in a study. Preventing this is not as difficult as it seems, however.

Any data-collection program a researcher chooses should provide information to the researchers about the data they are gathering, and this is doubly important for the researchers on the Internet. For instance, Collector, a program developed by Michael Garcia, Tyson Kerr, Adam Blake, and Nate Kornell, in conjunction with Victor Sungkhasettee, collects IP addresses and provides a means for checking to see if the participant changed tabs or switched windows. This can show how much attention a participant was paying, and can help researchers decide to include or exclude data. Data collection programs should also include attention checks, which would help to keep attention on the experiment. Most programs, including Collector, do have attention checks and IP address information available.

Another issue is that psychology participants are a self-selecting crowd. It has been estimated that each lab has about 7,300 participants, and that each participant is very likely to participate in other lab tasks (Steward, et. al., 2015). This points to another problem with online testing - a familiarity with tasks that are commonly used. Researchers must expect their participants to be very familiar with common tasks. There are reduced effect sizes for non-native populations, so though native Internet groups show the same results as in-lab populations, it is
highly likely that doing a common task will prevent the effect from being shown (Chandler et. al., 2015). Even MTurk people themselves have noted a lot of common problems being used, and have discussed it on forums.

It is also more difficult to publish papers where research is conducted only online. Because it is a newer way of data collection with a limited sample size of papers, it makes publishers reluctant. Running experiments simultaneously in-lab and online is becoming more and more common, however, and with it there has been a recent uptick in papers published with data collected online (Steward et. al., 2015). This is good news for researchers who want to gather large participant pools or do not have access to in-lab participants.

With these drawbacks, how can we as researchers improve conducting experiments online?

First, increasing pay for participants is necessary. Recruitment speed is affected by the pay of the task, which screens out participants by see task value alone. If a participant is considering doing a study, but sees that it pays lower than similar tasks that take similar times, they are less likely to participate in the study. Pay does not change the quality of the data, but it suggests that by providing a fair wage, researchers are more likely to gather a diverse participant group.

Collecting more demographics would help report the diversity of participant groups and the amount of attention participants are paying to the experiment. Collector already does this, and also reports on operating system and browser information. This is vital, because experiments look different and may function differently on Macs versus PCs, or Internet Explorer versus Chrome. If participants do not have the same experience it makes it difficult to interpret results. One thing that Collector and other programs do not record is screen resolution, which is also important. This will give information about whether or not people are doing these experiments and seeing the same thing, as well so what platform they are on. People on mobile might have a different layout or a
layout that looks fine on desktop is terrible and unusable on mobile. Collecting this data, though not necessary for experiments, would provide researchers with greater data and could be analyzed as part of research into using online participants.

Overall, the greatest safeguard of preventing bad data is the researcher. Collecting detailed demographics would allow the researcher to screen their data, and weed out data that comes from participants who do not operate under optimal conditions, such as participants who switch tabs a lot or participants who filled out the survey on their phone. The researcher who implements good checks, such as the ones suggested here, and reviews data carefully should have no problems collecting good, useable data from the Internet. This will hopefully contribute to an increase in the acceptability and use of studies carried out online, both in the publishing world and in the research world. The benefits of Internet testing outweigh the carefulness required in setting up an experiment.
References

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Action Perception and Prediction of Single and Multiple Actor Sequences

Alyssa Caparelli

Introduction

Traditionally, cortical systems for language and actions were believed to be completely independent of each other. This idea, referred to as the modular perspective, is supported by the fact that the language and motor systems have different cortical bases in certain restricted areas that can be subdivided into their finer functional systems (Pulvermuller, 2005). For example patients who have had a stroke move to one extremity while all other motor and language functions remain intact, which again suggests that the language and action systems are organized modularly. Modern theoretical perspectives suggest that the cortical systems for both language and action might actually interact with one another on a neuronal level.

An important example of interaction between language and action is that of actions words that are semantically related to different parts of the human anatomical structure. Action words are defined as verbs that specifically describe an action being performed (e.g. flick, punch, kick, kiss, etc). This brings into question whether or not the understanding of these action words activates the motor system somatotopically. If this somatotopic activation does occur, is it spontaneous? Neuroimaging studies have shown that the processing of the meaning of words occurs in specific cortical areas, including the temporal (Scott & Johnsrude, 2003; Price, 2000) and frontocentral areas (Martin & Chao, 2001; Pulvermuller, 2001; Martin, Wiggs, Ungerleider, & Haxby, 1996; Pulvermuller, Preissl, Lutzenberger, & Birbaumer, 1996). Following this discovery, functional magnetic resonance imaging (fMRI) showed activation in parts of the frontocentral motor system that were related to words being read. Action words that referred to specific parts of the human body such as the face, arms, or legs (e.g. lick, pick, and kick) elicited
activation of the motor and premotor cortex in a somatotopic fashion that specifically reflected
the body parts contributing to word-related actions as seen in Figure 1 (de Lafuente & Romo,

Neurophysiological experiments were conducted in order to establish the timespan
between the reading of the action words and the actual cortical activation, which consequently
determined whether the activation occurred spontaneously, or after a delayed period of time. It
was found that if the activation occurred spontaneously, it was due to semantic processes, which
have been found as early as 100-200 milliseconds (Figure 2). It was also found that if the
activation occurred after a delayed period of time, it was due to a late strategy to imagine the
action, which then resulted in cortical activation of the motor system. Late components of the
event-related potential (ERP) and field are maximal around 400 milliseconds after the reading of
the word.

Using the same actions words that were used in the fMRI study by Hauk et al., ERP
experiments were conducted, showing that the somatotopic motor system activation occurred
around 200 milliseconds, and therefore providing evidence that the activation was in fact
spontaneous. This spontaneity of the motor system activation was confirmed by MEG and EEG
results, which both resulted in an average time span of only 30 milliseconds (Pulvermuller,
2005). This concluded that the comprehension of action words specifically, rapidly, and
automatically activate the motor system in a somatotopic manner.

The current study attempts to measure the effect of being primed with an action word
before seeing the corresponding action being performed. This priming effect will be measured by
presenting an action word on a screen followed by a point-light figure partaking in the
corresponding action, and asking participants to quickly decide which action is being performed. Response times and accuracy will be measured, showing whether or not a priming effect exists. I hypothesize that an overall priming effect will in fact exist. Furthermore, this study will alter the SOA and orientation of the point-light figures in order to discover under what conditions this hypothesized priming effect is optimal.

Methods

Participants

A total of 32 undergraduate students from the University of California, Los Angeles (UCLA) participated in this experiment for 1 course credit. The participants consisted of both male and female students with normal or corrected vision. All of the participants signed up for the experiment through UCLA’s online subject pool website, SONA, and were unaware of the goals of this experiment.

Apparatus & Stimuli

The stimuli used in this experiment were point-light biological motion figures previously created using MATLAB. These point-light figures were presented on a solid background, and consisted of white dots representing the major joints of the body (one for head, two for shoulders, elbows, wrists, hips, knees, and feet). Each point-light figure was shown on the screen in fast moving frames, resulting in a moving action. The actions depicted by the point-light figures in this experiment consisted of either walking or running.
The point-light figures were presented on a CRT monitor. The participants kept their heads at a constant distance from the monitor. This was accomplished by using a chin-rest throughout the duration of the experiment. The use of this chin-rest ensured that the viewing distance would not differ throughout the experiment or between participants, which helped avoid any possible extraneous variables.

The experiment began with a practice run, consisting of 12 trials. This practice run was meant to give the participants an idea of what they would be asked to do throughout the experiment. During each trial of the practice run, the participants were presented with 1 of 3 possible words: Walk, Run, or Person (control). The appearance of the word “Walk” was followed by a walking point-light figure, whereas the word “Run” was followed by a running point-light figure. The word “Person” was followed by a point-light figure doing either of the two possible actions. The participants were asked to wait until the figure appeared, and quickly decide whether the figure was walking or running. The participants were asked to press the right arrow key if they believed that the figure was running, and press the left arrow key if they believed that the figure was walking. Between each trial a plus sign appeared on the screen. The participants could advance to the next trial by pressing the space bar. This practice run only provided feedback in the instances that the participants chose the wrong action or the response was too slow.

Following the 12 trials of the practice run, the participants began the actual experiment, which differed slightly from the practice run in stimulus-onset asynchrony (SOA) and rotation of the figures. The figures were rotated 180 degrees, 225 degrees, 270 degrees, 315 degrees, and 360 degrees. There were 3 different SOA’s measured consisting of 17 milliseconds, 300
milliseconds, and 1000 milliseconds (1 second). Each rotation of the figures was measured at each SOA. The participants were asked to press the right arrow key if they believed that the figure was running, and press the left arrow key if they believed that the figure was walking, similar to the practice run. Again, each trial was followed by a plus sign on the screen. The space bar was used to advance to the next trial.

Procedure

Upon arrival to the research lab, the participants were brought into a private room where the experiment was conducted. First, the participant was asked to complete the AQ questionnaire. The AQ questionnaire measures the magnitude of autistic traits in adults. The researcher left the room during the questionnaire. The questionnaire consists of 50 questions in which the participant is asked to rank whether they “definitely agree”, “slightly agree”, “slightly disagree” or “definitely disagree”. If the participants’ answer corresponds to an autistic trait, the score is increased by 1 point. The score indicates whether the participant has autistic tendencies, and to what degree these tendencies occur. The participant was asked to call the researcher back upon the completion of the AQ Questionnaire.

Following the AQ Questionnaire, the researcher opened MATLAB, and the participant was presented with instructions on the screen. Once the instructions were read, the researcher made sure that the participant understood the task and clarified any possible areas of confusion. The participant was asked to place his or her chin on the adjustable chin-rest, and press the space bar whenever he or she was ready to begin.
The researcher remained in the private room during the practice run, and answered any questions that the participant may have had. When the practice run concluded, the researcher explained to the participants that the experiment would now begin and would last about 30 minutes. The researcher then exited the room during the conduction of the experiment, and the door was shut to minimize distractions.

Results & Discussion

The experiment provided evidence that an overall priming effect does in fact exist. The increased SOA from 17 milliseconds to 300 milliseconds resulted in a stronger priming effect, although there was not much of a significant increase in priming effect between 300 milliseconds and 1000 milliseconds (1 second). It is possible that the priming effect could be influenced by the orientation of the figure. More research would be needed to conclude this, but the results of this experiment suggest that the frontal orientation of the figure negatively influence the priming effect. The changes in orientation and SOA seemed to cause larger differences in reaction times than in accuracy. Now that evidence of an overall priming effect has been provided, further research could include altering SOA to discover when exactly the priming effect is at its strongest.
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SOA

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SOA

control_trial  | control  | prime
References


Tests as a Learning Tool

Brandon Paulson

If having an intelligent, well-educated, and knowledgeable population is an important societal goal, it is important to consider how best to achieve that end. The primary goal of education is to induce learning in the student population, and it is imperative to determine the most effective and efficient way to do so. One way to increase learning that may seem intuitive is to simply increase study time; however, students already have very packed schedules and additional time is not readily available, making that an unattainable goal. One method of facilitating learning that has a robust amount of evidence to support it is the administration of tests, not as assessments, but rather as learning events. The “testing effect” is the finding that the act of taking a test enhances learning and retention, and has been widely demonstrated (reviewed in Roediger & Karpicke, 2006). Because testing seems to be such a profound method by which learning is enhanced, it is important understand why it is that tests are effective learning events.

In order to investigate the mechanism by which tests facilitate learning, Kornell, Klein, and Rawson (2015) performed a series of experiments that were designed to investigate whether or not retrieval success was necessary for testing to have a beneficial effect. The authors hypothesized that the benefit of testing is derived from attempting to retrieve the answer from memory, and therefore success on retrieval should have no effect on the amount of learning achieved. This hypothesis was based on a retrieval paradigm in which retrieval is a two-stage process. Stage 1 is the retrieval attempt, and stage 2 is the processing that is undergone after an answer becomes available, whether that answer is self-generated or externally given (Kornell et al., 2015). The authors’ hypothesis is that the benefit of attempted retrieval occurs entirely during stage 1 of this process, and the method by which the answer is obtained is irrelevant. In order to
test this assumption, a series of three experiments were conducted. In all three experiments, participants were first given a list of paired associates to study. Next they were tested in two different types of trials; in both types, the participants were given one word of a pair and asked to produce its associate. One trial type was a “copy” trial, in which, after their attempt to retrieve the answer, participants were shown the whole pair and asked to copy the correct associate. The other trial type was a “fragment” trial, in which, after their attempt to retrieve the answer, participants were shown the pair with the second word missing some of its letters and told to try and produce the correct word. The fragment trial was designed to be a way to induce successful retrieval, while avoiding item selection effects. All trials on which the participant was initially successful at retrieving the associate (before the whole pair or fragmented pair was presented) were thrown out, and only trials on which a correct response was entered after the whole or fragmented pair was presented were counted. Following a delay, the participants had a final test in which they were asked to produce the associates for all of the first words of the pairs. Differences between the experiments were trial time (4s in the first, 6s in the other two), delay time (2m and 24h in the first, 2m in the other two), length list (60 pairs for the first two, 40 for the third), and type of fragmentation (all vowels missing for the associate word in the first two, only first four letters of the word present in the third).

The results of the Kornell et al. (2015) experiments were conflicting. The first experiment showed no significant differences in performance on the final test between the two trial types, confirming the authors’ hypothesis that successful retrieval is not a reason that retrieval practice enhances learning. Results for the second experiment showed that pairs in the fragmentation trials were significantly better recalled during the final test, although that benefit was numerically very slim. Conversely, results for the third experiment showed that pairs that
appeared in the copy trials were significantly better remembered on the final test. Based on the collective results of all three experiments, not much can be definitively concluded; however, the results do suggest that successful retrieval is not important, or at least not very important, to the benefit of retrieval practice.

A study by Arnold and McDermott (2013) attempted to isolate the indirect from the direct effects of retrieval practice on subsequent memory. In order to accomplish this, the authors conducted a between-subjects experiment in which both groups were first given a chance to study 25 Russian-English word pairs. One group was then administered five tests in between the initial study and the first restudy opportunity, and between each further restudy opportunity for a total of 1 study event, 15 testing events, and 3 restudy events before the final test was given. The other group took a test after the initial study, then had a restudy event, and then took tests in between each restudy opportunity for a total of 1 study event, 9 testing events, and 9 restudy events before the final test. In order to discriminate between the direct and indirect testing effects, the authors focused their analysis on only those answers that were correctly answered for the first time following a restudy period for they could only have benefitted from the test-potentiated learning effect because there was no forgetting possible to protect against (Arnold & McDermott, 2013). The results of the experiment showed that significantly more items were correctly retrieved for the first time following the first restudy period for the group that had taken five tests before the restudy event, than were correctly retrieved for the first time following the first restudy event for the group that had only had one test before the restudy event. This same significant result was found for the second restudy period, and the trend was again replicated for the third restudy period, although the results for the third restudy period did not reach significance. Overall, these results strongly support the hypothesis that testing has significant
indirect effects through the potentiation of subsequent learning, in addition to the direct effects of protecting against forgetting.

One aspect of using testing to enhance learning that must be examined is if and when to provide feedback. Some research has shown that testing that produces unsuccessful retrieval attempts is beneficial only if feedback is given immediately (reviewed in Kornell, 2014). The studies that showed this, however, used paired associates for which there was no intrinsically correct answer. Kornell (2014) conducted a series of experiments that sought to investigate both the effects of delay between test and feedback, as well as the effects of using different, more meaningful stimuli. The first experiment was a replication of the results that suggested that unsuccessful retrieval only benefitted learning if feedback was immediate. In this experiment, participants were given three sorts of trials in which they learned pairs of words to be recalled on a final test: study only, test-study, and test-delay-study trial types. For the delay trials, the delay was four minutes in between testing and feedback. The results showed that, consistent with previous findings, test-study trial words were better recalled during the final test than were study-only trial words, and this benefit of testing was not found for the trial types in which there was a delay between test and feedback.

The second experiment conducted by Kornell (2014) was identical to the first, except that trivia questions and their answers were used instead of paired associates. The results of this experiment showed that questions given in the test-study trials were significantly more often recalled during the final test than study-only questions, and additionally, that test-delay-study questions were significantly better recalled on the final test than were study-only questions. These results demonstrate that testing before studying has benefits on learning, even after a delay, if the materials to be learned are facts with intrinsically correct answers.
Kornell’s (2014) third experiment was similar to the second, but the delays between test and study for the test-delay-study trials, and between study and test for all three trial types, were increased to 24h. Additionally, participants were given the freedom to decide how long they spent guessing the answer on both the initial and final tests, and how long they wanted to study the correct answer for during the study periods. The results for this experiment were consistent with the findings of the second experiment. The questions that were presented in the test-delay-study trials were significantly more often recalled than were questions studies with their answers in the study-only trials. This third experiment is important because increasing the time of delay before feedback to 24h much more accurately represents scenarios encountered in the real world than does a delay of 4m. From a pragmatic standpoint, if testing is a viable method to enhance learning, than realistic delays between the time of testing and the time of feedback being given must still produce the same beneficial result seen after a short delay or no delay at all.

One major obstacle to education’s goal of creating a more intelligent and well-educated population is the lack of additional available time that can be dedicated to learning. The best way to overcome this challenge may be to increase the efficiency of studying and learning, and tests have been shown to be a powerful tool by which learning can be augmented and expedited. If the evidence for the testing effect is going to be applied pragmatically to the process of educating, then it is important to understand the mechanisms by which it works and the limitations of when retrieval practice will be beneficial. From the data derived from the wealth of studies that have been conducted in this area, it seems likely that the beneficial effects of retrieval practice come from the process of attempting to retrieve an answer, and that the success or failure of that retrieval is irrelevant to whether or not learning will be enhanced. Additionally, the act of taking a test seems to enhance subsequent learning in an indirect way, and does not only work to
prevent forgetting. Although some studies have shown that a delay between test and feedback can negate the beneficial effects of the test, there is evidence that the type of material being studied influences whether or not the delay will prevent the beneficially effects of the test. Future research could be conducted to investigate more thoroughly the interaction between delay of feedback and type of material, such that the knowledge can be more effectively applied pragmatically to the classroom setting.
Works Cited


The Effects on Effort of Examining Fewer Cues in Decision-Making

Bryce Wong

As noticed by Spock of the “Star Trek” franchise, humans are not perfectly rational beings. We don’t make decisions based on choices that maximize the most utility. How then do we process information to aid us in our decision-making?

Past research on the study of decision-making has formed the Principle of Bounded Rationality, a principle that postulates human rationality as restricted by limited cognitive resources. Notably, Simon (1990) has discussed how the storing of knowledge and strategies reducing processing requirements can help lessen the limits of bounded rationality. In particular, Simon defines heuristics as an adaptive technique that can make the search for solutions to a problem more selective. His definition of heuristics considers them as rules of thumb which guide decision-making among a wide array of possibilities.

A different conceptual framework for defining heuristics is proposed by Shah and Oppenheimer (2008). They argue that in order to better study heuristics, the designation of the term heuristics must be made clearer. Shah and Oppenheimer suggest that heuristics are more than simply strategies used, but strategies that are used specifically to reduce effort in the decision-making process. To provide a more rigorous basis for studying heuristics, they offer a framework for studying how heuristics can reduce effort. Their framework theorizes that all heuristics utilize one or more of five effort-reduction methods. The first named method is the examining of fewer cues. While Shah and Oppenheimer acknowledge that researchers must be careful when arguing that any process using fewer cues is effort-reducing, they still maintain that when a process uses only a subset of available cues, that particular process can be defined as a heuristic.
However, processes requiring subsets of available cues but that are more effortful have been studied in the past. Stroop (1935) explored the interference of conflicting color stimuli upon reading words compared with the interference of conflicting word stimuli upon naming colors. He found that the interference was greater with conflicting word stimuli and he postulated that this might be because the association between word stimuli and the reading response is a stronger association than the one between color stimuli and the reading response. Stroop discusses how this could be explained by word stimuli having been trained to be associated with the reading response for much longer than color stimuli having been trained to be associated with that particular response. Thus, ignoring an association that has been trained for longer is more difficult than ignoring one that hasn’t. We could study an expansion of this and examine how the ignoring of a trained association or cue requires more effort than continuing to observe it.

Our study aims to explore whether effort required to ignore a trained association may be increased instead of reduced, supporting the idea that examining a subset of available cues may not always produce an effort-reducing heuristic. In extending Stroop’s interference effect to the study of decision-making, we hypothesize that once trained to associate a certain cue with the value of a gemstone, the ignoring of that cue in evaluating subsequent gemstones will increase the effort of the evaluation process.

**Method**

**Participants**

The participants will be University of California, Los Angeles undergraduate students who volunteer to participate in the study, possibly for course credit.

**Design**
One independent variable manipulated is validity of the hue. The two levels are hue valid and hue not valid. Hue valid indicates that the participant is instructed to incorporate the color of the stone into the estimation of its price. Hue not valid means the participant is instructed that the color of the stone does not influence its price. A second independent variable manipulated is the presentation color of the stones. The two levels of this variable are color presentation and black and white presentation. Stones in the color presentation are displayed in color ink. Stones in the black and white presentation are displayed in only black and white ink.

The dependent variables measured are response time, accuracy, and correlation between participants’ estimated prices and stone hue. These indicators will measure “effort” required in the decision-making process. The experiment is a between-subjects design.

Materials

A total of around 175 different photographs of singular stones will be compiled in each stone type (aquamarine and topaz). Stones in the photographs are rough cut, transparent to semi-transparent, and edited to remove significant impurities.

To help acquire an even spread of stones among each continuous range for hue, size, and darkness chosen, categories are created to initially sort the stones. Collected stones are evenly distributed into three categories of hues, five levels of darkness, and five levels of size. Each stone is manipulated in photo editing software to fit a single category of 75 possible combinations of hue, darkness, and size. The hue category of each stone is determined by calculating the ratio of the photograph’s blue value to the photograph’s green value in photo editing software. The “greenest” stones fall between a ratio of 0.8-0.9, the “middle” stones fall between 0.9-1.0, and the “bluest” stones fall between 1.0-1.1. The five categories of darkness are determined using the grayscale value of each photograph in photo editing software. Stones that
have a grayscale value in the range of 70-98 are in the “darkest” category, stones in the range of 98-126 are in the “darkish” category, stones in the range of 126-154 are in the “medium” category, stones in the range of 154-182 are in the “lightish” category, and stones in the range of 182-210 are in the “lightest” category. The five categories of size are similarly defined as groups of ranges going from smallest to largest. Stones are edited onto a white background with the copper penny placed next to it for size comparison.

The final edited photograph of each stone will be placed onto its own virtual flashcard on a computer program. Participants are taught that each collection of stone ranges in price from $100 to $400 with an average price of around $250. Each stone’s price is determined using a formula that evenly weights all cues indicated as valid. The absolute value of each cue, and not its category, is used to determine price. Photos will be presented in a randomized order using an online program. This randomization will help counterbalance the confounding specific item effect that could occur when all participants have the same order of conditions across groups. We manipulate the stones so that every cue combination is represented to counterbalance any confounding effects that may arise from any one combination being over or underrepresented.

Participants will view both a trial of 150 randomized topaz stones and a trial of 150 aquamarine stones. The trial of aquamarine stones may be presented in black and white. Additional materials include instructions and additional computerized flashcards of stones for training the participants.

Procedure

Participants are randomly assigned to a condition. In all conditions, they will first undergo training, in which they will be instructed that they are to complete a hypothetical gemstone evaluation assignment. For each stone they are taught to recognize the cues that
increase or decrease the price value of the stone. Participants will make their estimates and then will receive feedback for sample photographs.

The training is followed by the testing phase. In all conditions, the first set of stones in the testing phase has the participant estimating the value of the stone in the same way they estimated the value of the stones in the training section. Participants do not receive feedback. For the second set of stones, each condition will have the participants estimating the value of the stones in different ways. One condition will have participants estimating stone value in the same way as the first set while still using color photographs. A second condition will have participants estimating stone value in the same way, but stones are presented in black and white. Another condition will have participants estimating stone value without incorporating the stone hue, although stones will still be presented in color ink. The final condition will have participants also estimating stone value without factoring stone hue into the estimating, however the stones will be presented in black and white. Throughout the testing phase, participants’ speed and accuracy in estimating price will be recorded for every stone. Their accuracy for each hue category in both sets of stones will also be recorded.

**Expected Results**

The study hypothesizes that, once trained to utilize a cue, participants will find that it requires more effort to ignore this cue than to continue using it. Under the assumption that a process that requires more effort is slower and less accurate, we expect that, on average, there will be a greater accuracy and a faster assessment of a stone in the color and hue valid condition than in the color and hue not valid condition. It may also be that participants will find the ignoring of a cue to be so effortful that they will still incorporate it into their assessments even when instructed not to. Therefore, we also predict that there will be a correlation between hue
category and estimated price in the color and hue not valid condition. Because hue is not valid, there should not be a correlation in this condition. These findings will reinforce our idea that the examining of fewer cues does not necessarily categorize a strategy as an effort-reducing heuristic as postulated by Shah and Oppenheimer (2008).

Similarly, compared to the color and hue valid condition, we predict that overall accuracy in the color and hue not valid condition will go down from the first trial to the second as participants find the new process so effortful it is initially difficult to adjust to. As with the association between word stimuli and the reading response being stronger by virtue of being trained longer in the Stroop (1935) study, because an association between hue and price has been trained for longer than no association between hue and price, the difficulty of ignoring the association is increased. When a cue is not available, participants should have less of a problem ignoring it, thus we expect that there will be no difference in average accuracy and speed per a stone among hue valid and hue not valid in both black and white presentation conditions.

The findings of this study may be limited by participants having different interpretations of a stone’s overall hue, darkness, and size. The study must also be careful to counterbalance cues so that any intuitive perceptions of the value of a particular cue category will not confound the results. However, the exploration that this study does into how the examining of fewer cues influences decision-making processes can help define whether this method really does undoubtedly reduce effort or not. While heuristics are not just Simon’s (1990) rules of thumb, the analysis of what makes a heuristic is still a topic that must be carefully studied. Reevaluating the validity of proposed methods of effort-reduction can help streamline our definition of heuristics and allow us to analyze decision-making more thoroughly. One could say we must be as methodical as Spock in our study of decision-making.
References


Cognitive remodeling: dealing with stereotype threat

Christopher Yeh

The iOS based app proposal below describes a model for an app that aims to support psychologically individuals experiencing stereotype threat. Stereotype threat results from individuals’ fear of confirming a stereotype and thereby resulting in anxiety that hinders cognitive performance. To maximize the benefits of such an app, we first think about what types of audience we should aim for. The first obvious fact is that if we name it “coping with stereotype threat”, only people who strongly feels they are facing stereotype threat would download this app. However, most of the people at risk for stereotype threat does not know the existence of this social phenomenon. Therefore, we need a way to camouflage the app, at least at a first glance basis, to attract an efficient group of potential audience. The main task, therefore, would be to select an efficient app name. For example, a title such as “iAm, self-help: be confident about who you are” would attract an audience that are experiencing identity issues but does not know why while at the same time is not too ambiguous as it points directly to stereotype threat. Next, we need to put a strong emphasis on the design since this is a “feel good” app. Most of the successful self-help apps out there have a strong design. In fact, we should even have people submit competing designs, the winner of which will have his or her name on the app, and maybe receive a mild financial reward.

Stereotype threat is a strongly studied area in social psychology. Many techniques have been shown to be effective in dealing with stereotype threat, most of which can be realized in an app. Cohen et al. showed that self-affirmation, where a subject writes what qualities she (he) is happy
with about herself, can help reduce stereotype threat (Cohen, Garcia, Apfel, & Master, 2006). Johns et al. showed that simply knowing the existence of the stereotype threat can help reduce stereotype threat (Johns, Toni, & Andy, 2005). Walton et al. showed that knowing that she (he) belongs in an intellectual community can also reduce stereotype threat (Walton & Geoffrey, 2007).

Here we list the flow chart for the app. The first time the user opens the app, the user will encounter a brief introduction to stereotype threat which can be simply pushed away if the author wishes to view it later. Next, the user will be shown a tutorial for the app in a quick guide through format showing the various functions. Then, the user will be asked to go through a brief survey which will help us customize the content of the app. The survey can be delayed but is strongly encouraged (with a notification sign) to be filled out before the usage of the app. The customizable content will determine the daily facts given to the user, the image shown on the main screen (the theme of the app) and the relevant group for which the discussion posts will be posted to. The menu then in turns has several tabs which will lead to several contents. The “Diary” tab lead to postings. The “awareness” tab leads to a list of emotional states. The “community” tab leads to discussion and counselor. Then, there is the “hypnosis” and “daily facts” tab. The main menu of the app is shown in figure 1.
The “Diary” tab will lead to a list of journals that the user has written in the past. It can be viewed as a list form or a calendar form. In the calendar form, a calendar is shown where the days for which a post was written is notated. The user is encouraged to write about things that he feels good about himself, which is in line with Cohen’s self-affirmation theory. The user can also engage in a philosophical debate about the nature of his identity or simply write about the thoughts he has at that time. The important thing is as follows. The user can choose to post his writing in a forum relating to his identity. The group that the post will post to is suggested by the survey that the user filled out in the beginning. However, the user can choose to post to any forum that he likes. The possible groups are “racial”, “gender” and any identity that we can recognize later. Every week, the posts will be ranked by an administrator and the person who wrote the posts will be rewarded with points according to the ranking. Each person’s post in the future will have a notation of the number of points he has received and the corresponding level of that points. In my experience, the point system is very encouraging for postings.

The “awareness” tab can be employed by the user at two scenarios. The first is at the end of the day each day. The user will receive a reminder to answer the feeling tab at the end of each day if he wishes to do so. The user can also choose to answer the tab whenever he feels he is in a situation that involves stereotype threat. The tab merely asks the question “what are you feeling right now?” for the situation type or “how did you feel today” for the end-of-the-day type. The tab consists of a list of emotions such as “confident”, “courageous”, “elated”, “disabled”, “fearful”, “angry”, “threatened”, “inspired”, “sad”, “worried”, etc. with a percentage slider. This will be helpful in that the user only needs a short amount of time to select a response. The user can, later on, choose to come back and write a note about the choice. A button on the tab will
allow the user to see what kind of emotions has been chosen in the past and how the choices have evolved. The user can then choose to share his profile with his friends, and can in turn see what his friends has chosen.

The “community” tab has three different subtabs. The “forum” tab allows the user to see what other people has written from in “Diary” tab. The “chat and poll” function allows for an unguided anonymous chat in which the user can post questions and answer other’s questions without the guide of a professional counselor. It also allows the user to setup a poll for which the others can vote for. Having a sense of community is important according to Walton et al. (Walton & Geoffrey, 2007). The “guided discussion” allows the user to chat with a counselor anonymously by setting up appointments or following scheduled discussion time.

The “daily hypnosis” tab updates daily a hypnosis for which the user can listen to that helps enhance his confidence. We can obtain the hypnosis online or have specialized personal record them. The “daily facts” tab provides some facts about stereotype threat to the user in a condensed format. The user can choose to listen to past hypnosis or look at past facts. The facts can be pushed notified if the user wishes. The facts should be kept simple in two or three sentences. For example, “Did you know that anxiety resulting from stereotype threat decreases performance by depleting working memory?” Just having knowledge about stereotype threat is a very good start to mitigate its effect according to Johns et al. (Johns, Toni, & Andy, 2005).

The “notification” tab will give the user daily updates about ongoing seminars or newly published studies around them. It will also show if their post has been given a response or that
their post was chosen to be the week’s best post. The “Settings” tab allows the user to set notification settings or log out.

To summarize, we have the “Diary” tab in which the user can post his thoughts. In the “awareness” tab, the user can quickly record his ongoing emotions. In the “community” tab, the user can engage in guided or unguided discussions. In the “hypnosis” tab, the user can listen to professional hypnosis, enhancing his confidence meditatively. In the “daily facts” tab, the user can learn about trivia. The “notification” and “setting” tab is for administrative purposes. The user can also use the search function for which the word will be searched through the forums, postings, and chats. Frankly, I am most worried about the commercializing aspect of the app. It seems that the app will likely be one of those that they first thought is interesting but uses less and less. To mitigate such effects we implement the point system in the forum and focuses a lot on design. However, I strongly believe this is not enough, and that more ideas will be needed for such implementation.

On the technical front, all of the functions listed above should not be hard to implement. I might need some help to deal with the network aspect of posting and account settings. Needing an administrator and an experienced counselor may require a little work. However, I do believe that school counselors would be happy to help us out if every other aspects of the app was successful.
References


The Role of Divergent and Convergent Thinking in Exceptional Big-C Creativity

Claire Crinion

Introduction

In many ways, creativity is an enigmatic concept. It is an essential component of our daily lives, but it also drives the progress of human innovation. We easily recognize creativity around us in the world, whether it be inventive developments in technology, groundbreaking scientific advancements, or artwork that captures our attention and intrigues us. Humans are also aware of our own quotidian creativity— we swell with pride when we’ve come up with a witty pun or created an effective solution to a problem at work. But, people do not have an introspective understanding of the cognitive processes taking place in their brain when that metaphorical lightbulb goes off.

Compare yourself making a clever wordplay with Einstein discovering the theory of relativity, or Picasso developing Cubism. Are these events each based on the same creative processes in different levels of magnitude? Or are there qualitative differences in these manifestations of creativity?

Creative Orders of Magnitude

In an academic context, your wordplay and Einstein and Picasso’s lifetime creative achievements are considered different in terms of creativity. Everyday problem solving and novice creative endeavors are not the same as eminent genius, and they are distinguished as little c and Big C creativity, respectively. This idea, first introduced by Stein and Csikszentmihalyi (Stein 1953, Csikszentmihalyi, 1996), allows a useful distinction between the kind of creativity we use in going about our daily lives and the kind that produces masterpieces or advances entire fields of study. Distinguishing these two concepts allows researchers to focus on studying one.
level of creative magnitude, such as eminent creativity, without failing to recognize other levels on the spectrum of creative magnitude. Some scientists have actually made further distinctions along the spectrum of creativity in order to resolve limitations set forth by the little c/Big C dichotomy. Such additional categories include mini-c, which distinguishes subjective and objective forms of little-c creativity, and pro-c, which creates a category for people who are creative on a professional level but have not reached eminent level status (Beghetto & Kauffman, 2007). Here, we will continue to use the little-c/ Big-C dichotomy as that is what the Big-C study has focused on.

**Defining Creativity: Novelty and Usefulness**

Beyond order of magnitude, creativity is typically defined by invoking two criteria: novelty and usefulness. Creative ideas and works have been assessed as involving the creation of a new concept, as well as that concept being useful or valuable in some way. These two concepts are used both informally to help explain what it is to be creative, and also as formal criteria upon which to measure the degree of creativity in a particular behavior or response.

In terms of little-c creativity, novelty and usefulness can be delineated in the example of the creation of a delicious new dish using all the leftover ingredients in one’s refrigerator. This is novel because it is a new creation, not made using a given recipe. Its usefulness comes from its value in being an appetizing thing to eat, as well as the value in successfully combining several items that needed to be used up.

For Big-C creativity in the domain of science, it is easy to see where novelty and usefulness come into play. We might think of an exceptionally creative scientist as one who has made new contributions to their field in ways which advance the field of study or illuminate
some useful process or technology. It seems clear that creative scientific achievements should be things that are both novel as well as useful and valuable to the field of interest.

In the case of Big-C creativity in the domain of art, using novelty and usefulness as criteria for creativity can seem a bit more dubious. Most people would accept that, like in science, novelty is important for an artistic work to be considered creative. However, skeptics of these two criteria for creativity may think that they cannot apply to artistic creativity because art is not inherently ‘useful’. This isn’t necessarily a fair judgement— it is possible to conceptualize how usefulness can apply to art. The idea of usefulness with regard to art is related to the value of the artwork in contributing ideas to society. Artwork that produces meaningful ideas within its societal context is useful, as is artwork that expresses feelings or beliefs within a particular medium in a valuable way. As such, it can be seen that novelty and usefulness are suitable criteria for describing creativity across various magnitudes and domains.

**Benefits of Understanding Creativity**

Clearly, creativity is a positive force in our individual lives and in society in general. Findings ways to produce creativity in ourselves, our students, and within our organizations is valuable because creativity is necessary for problem solving, scientific advancement, and innovative art. Researching the differences between Big-C and little-c creativity can help us understand various aspects of creativity and how they might differ in everyday creative acts vs. acts of eminent creativity. This kind of understanding has profound implications for ways in which we can engender creativity in a little-c magnitude as well as recognize and cultivate potential eminent creativity.

If we understand the processes and traits that are indicative of creativity, that information can be used in several ways. We can incorporate them into education, and use creativity training
in the classroom to nurture creative potential amongst students. Creativity research may have implications for changes in educational policy and practices in terms of how we include creativity in the classroom and how we assess students (Beghetto, 2010). It also may make it easier to recognize that creative potential within individuals in the first place.

Further, it is particularly important to study exceptional creativity. Thought-provoking art, scientific progress and technological innovation are all greatly valued in our society. Knowledge of the components of creativity that produce these works would be indispensable in furthering the fields.

**Divergent Thinking vs. Convergent Thinking**

The concept of divergent thinking appears so frequently in the creativity literature that it often seems as if tests of divergent thinking are an absolute measure of creativity. Despite this not being the case, divergent thinking is indeed significant in the field of creativity studies.

Divergent thinking (DT) was first introduced by Joy Guilford with his Structure of the Intellect model. Guilford conceptualized performance on intelligence tests to be related to various underlying mental abilities in different dimensions. One of these mental abilities was what he called divergent production, the process by which one generates multiple ideas or answers to a problem. He contrasted this with convergent production, the process of converging on a single correct answer (Guilford, 1956).

Guilford theorized that divergent thinking has several characteristics; fluency, originality, flexibility, and elaboration. Fluency corresponds to the number of solutions or ideas produced, flexibility to the use of a variety of approaches to a problem, originality to the production of new and original ideas, and elaboration to the ability to organize and carry out ideas to a solution (Guilford, 1956). These aspects of DT align well with the previously discussed criteria for
creativity; novelty and usefulness. Originality appears to correspond to novelty, and the combination of flexibility and elaboration seems to approach the concept of usefulness.

Throughout the history of DT research, its correlation with creativity has been in dispute. First thought to be highly indicative of creative potential, its predictive validity was later criticized widely. Currently, divergent thinking is considered to be useful in reflecting the potential for creative ideation and problem solving.

Convergent thinking has not traditionally been linked to creativity. Rather, convergent thinking, distinguished from divergent thinking by Guilford (1956), has often been considered to be the opposite of divergent thinking. Convergent thinking refers to cognitive processes that arrive at a single correct answer. We use convergent thinking when answering questions such as “What is the capital of Germany?”, or “What is the square root of 144?”. In answering these questions, we need to recognize what the question demands, retrieve stored information, and apply it to come up with the best answer to the question.

Many researchers have presented theories recognizing that divergent and convergent thinking may work together in the creative process. These include various theories conceptualizing different phases of the creative process as being divergent & convergent, or ideational and evaluative (Runco and Acar, 2012). One study of creative reasoning found that convergent thinking and divergent thinking acted in integration, rather than as independent process components (Jaarsveld, Lachmann, van Luewen, 2012). Cropley posits that much of the variability produced in divergent thinking does not meet the standards of creativity, and that convergent thinking is required to facilitate the effectiveness of the novelty from divergent production (Cropley, 2006).
It seems worthwhile to further investigate the interaction of divergent and convergent thinking as it applies to creativity. This study will use an Unusual Uses Task and a Remote Associates Task to do so.

**TTCT Unusual Uses and Remote Associates Test**

The most commonly used measure of DT is called the Torrance Tests of Creative Thinking (TTCT), developed by E. Paul Torrance (Torrance, 1972). The various tasks in the Torrance Tests were designed to measure the four most commonly described aspects of DT: fluency, originality, flexibility, and elaboration (Runco, 2010).

Guilford first developed a task measuring DT called Alternative Uses (Guilford, Christensen, Merrifield, & Wilson, 1960), a version of which appears in the TTCT under the name Unusual Uses. Guilford’s Alternative Uses asks subject to list as many possible uses for a household item (brick, paperclip, etc.) as they can. In the Unusual Uses paradigm within the TTCT, subjects are asked to generate uses of cardboard boxes (Torrance, 1972). For example, with cardboard boxes as the use item, an examinee may mention using them as insulation, kindling, or a fort. This is a typical divergent thinking task because the goal is to generate as many different & unusual uses as possible.

A task analysis of the Alternative Uses paradigm analyzed the processes involved in this type of task and sorted the various strategies that subjects use into the categories of memory use production, property use production, broad-based use production, and disassembly use production. Memory use production refers to the generation of uses that the subject recalls from memory. Property use generation is the strategy of thinking about the properties of the given object and uses these properties as cues to generate new uses. Broad-use based production is considering the use of the object in terms of broad uses. Lastly, disassembly use production is the
process of imagining the disassembly of an object and using its components to come up with ideas for uses (Gilhooly, Fioratou, Anthony & Wynn, 2007). Given this breakdown of the various cognitive processes involved in the Unusual Uses paradigm, it seems evident that phases of convergent thinking would be useful, and possibly necessary, for effective use generation. For example, convergent thinking would be required to understand how to disassemble an object, and also to evaluate the practical utility of various uses.

One model for assessing creativity using convergent thinking processes is Mednick’s 1962 model of creative thought, which defined the creative process as based on associations attained through serendipity, similarity, and mediation by common elements. Also included is the idea of an associative hierarchy, which is steep if only typical & common associations are made, or flat if there are more responses from a variety of different categories.

Out of this model came the Remote Associates Test (RAT), which was originally considered to be measuring divergent thinking because it assessed creativity. Mednick’s concept of remote associates is that of ideas produced late in the associative process. They are further from the starting point of the associative process, and as such, more remote. These ideas are more likely to be novel (Mednick 1962). The use of RAT as a measure of DT began to change around the 1960s, and in 1966 it was concluded that it was actually better suited as a measure for convergent thinking, because it is dependent on verbal ability and there is only one correct answer (Taft and Rossiter, 1966).

The test involves the presentation of sets of three common words with no apparent link, and the task is to come up with the fourth word that is related (remotely associated) to all 3 words in a set. For example, an examinee may be presented with the set of words:”sore,
shoulder, sweat”, for which the fourth word is “cold”. The stimulus sets vary, some demanding a very abstract association to the fourth word, while others are more easily recognizable.

I aim to examine the differences in convergent and divergent thinking of Big-C creative individuals and a “Smart Comparison Group” unselected for creative achievement but matched in sex, age, ethnicity, and education level using the Unusual Uses and Remote Associates measures outlined above. Due to prior findings showing integration and co-facilitation of convergent and divergent processes resulting in higher-level creativity, I hypothesize that there will be an interaction effect of higher performance on both convergent and divergent tasks within the Big-C group, relative to the Smart Comparison Group.
References


Effects of Priming on Visual Recognition

Moshe Daniel Levine

Abstract

UCLA undergraduates were primed with action-words in an attempt to test the effects of priming on visual recognition. The results showed that an increase of time between the initial stimulus (the prime) and the probe allowed participants to recognize the probe at a fast rate, but with equal accuracy. Further studies will take these findings and measure the effects of priming on brain wave oscillatory patterns.

Introduction

As current research is beginning to show, working memory is highly influenced by neuronal communication between the frontal and parietal regions of the brain. In fact, externally induced stimulation of the frontal and parietal lobes with theta stimulation has been shown to improve visual memory-matching reaction times as compared participants that underwent placebo stimulation (Polania 2012). In the opposite vein, theta desynchronization has been proven to deteriorate performance (Polania 2012). The causality of theta phase-coupling of two different areas of the brain that result in improved cognitive performance, is a phenomenon that shows the ability of brain oscillations to contribute to information processing by coordinating phases of high-excitability between neuronal populations.
Brain oscillations are rhythmic fluctuations in local field potentials (LFPs) that can be recorded either directly or by more invasive methods such as magnetoencephalography and electroencephalography (Thut 2012). A fundamental computational principle that is spelled out in the “communication through coherence” hypothesis posits that modulation of oscillatory phase relationships among neuronal populations causes communication (as we discussed with the theta phase coupling above, Thut 2012). Specifically, in order to have effective communication between neuronal populations, both populations must display phase-locked oscillations with a phase-delay; this delay should be the same amount of time as it takes for the signal to get from the sending-group to the receiving-group (Thut 2012).

In order to explain the details of neuronal-activity regarding priming phenomena, we take advantage of the aforementioned information and hope to understand the effects of coordinated oscillatory phase-activity upon visual priming, specifically. Context effects have a large influence on visual processing; for example, Loftus and colleagues have shown that the gist of a scene is most often acquired during the first eye-fixation upon a scene (Loftus, Nelson, Kallman 1983). If one is presented with pictures of objects or words that are related to the scene upon which an individual had just fixated, he will more quickly identify the object or word (as opposed to an individual who had not been given an opportunity for prior fixation).

In our experiment we implemented priming experiments similar to Loftus and others, in which we instead primed participants with words, subsequently probing them with visual display. Currently, we aim to test the efficacy of our study design and in the future we will conduct experimentation
that will monitor brain oscillations within the context of our visual priming paradigm. As others
have described, we predict that the prime will initiate a specific slew of firing patterns which will
then trigger a myriad of possible predictions about the external environment at that moment in
time (Haung, Chen, Luo 2015). Simultaneously, the probe will trigger a specific oscillatory pattern
and if this pattern culminates within the correct timing of stimulus-onset asynchrony (SOA), the
amount of time between the onset of the first to second stimulus, judgements made in regard to
displayed probes should be more accurate (Haung, Chen, Luo 2015).

Here, we look to establish a priming paradigm that will be followed-up by future experiments that
will test the effects of brain stimulation on the accuracy of this visual recognition task.

Methods

Participants

About 40 undergraduate students from UCLA took this study for extra credit in various psychology
courses.

Materials

All tests were done on a desktop computer. The priming stimuli included the words “Run” or
“Walk” followed by a pixelated scene of a person walking or running at various angles.
Procedure

Upon arrival to the experimentation room, participants were asked to fill out their name, age, and UCLA ID. Once the experiment started participants were seated in a chair behind a desktop computer, with their chin resting on a stand so that their eyes were fixated on a cross in the center of the screen. Before data began recording participants were given a few practice trials and did not start the experiment until they were able to record a few correct answers.

Within each trial the participant had their eyes fixated on the center of the screen and pressed the space-bar to begin. Immediately the word “Run” or “Walk” would flash on the screen, via random ordering. After the word disappeared there would be a slight delay and then a scene of a person walking or running at various angles. The five different angles were as follows: $180 = \text{side view, actor moving to the right}$, $225 = \text{actor moving toward observer slightly right}$, $270 = \text{frontal, actor moving directly toward observer}$, $315 = \text{actor moving toward observer slightly left}$, $360 = \text{side view, actor moving to the left}$.

In reaction to the movement stimuli, participants were asked to judge whether or not they felt that the character was running or walking. Their judgments were recorded via two different keys, one letter corresponding to walk and one letter corresponding to run.

Results

In order to test the effects of word-priming upon visual recognition, a cohort of UCLA students were enrolled in the study and participated in the priming task at hand. Clearly, there is an overall
priming effect, indicated by the lowered reaction time (RT) of the primed group compared to the control in all 5 rotation scenarios (Fig. 1). Interestingly, with lengthened stimulus-onset asynchrony (SOA) the priming effect is more pronounced, as indicated by the difference in 17ms SOA and 300ms SOA; seemingly, there is no added benefit of the lengthened SOA of 1000ms, as these results are comparable with those of the 300ms trial (Fig. 1). Although the difference is sight, there may be a benefit to action recognition when observing the actor from a side-view or moving from a slight angle (moving to the right or the left, Fig. 1A, B, D, E) as opposed to moving towards the observer directly (Fig. 1C).

Regarding accuracy (ACC) of the task, there is seemingly no difference between the primed and the control groups (Fig. 2). Perhaps, there is a trend in higher ACC in the primed group; results do not seem significant. SOA timing also has no effect on increased accuracy either.
Figure 1: Reaction time (RT) versus stimulus-onset asynchrony (SOA): Control (red) and primed (blue) groups probed with different versions of visual display (degrees of rotation differed between trials A-E). Lower RT is apparent for primed vs. control groups. Slight benefit to angled display vs. head-on display.
Figure 2: Accuracy (ACC) versus stimulus-onset asynchrony (SOA): Control (red) and primed (blue) groups probed with different versions of visual display (degrees of rotation differed between trials A-E). No significant difference in ACC, although slight benefit for primed group.

Discussion

In this paper, we attempted to establish a priming paradigm which will ultimately be used to test the effects of brain stimulation upon priming. We concluded that visual priming has an added benefit upon reaction time (RT), generally. When differentiating between the SOA periods, there is a clear benefit when SOA rises from 17ms to 300ms; however, there is little difference between
the 300ms and 1000ms SOA frames. This delay in SOA may allow for participants to internalize
the displayed word with more “confidence,” leading to a hastened reaction time. Interestingly,
though, there is little contribution of this lengthened SOA to accuracy (ACC). This phenomenon
is important in that it establishes an internal control for the experimenter-- suggesting that the
participants all cognitively understand the words appearing in front of them when primed and the
added benefit is solely derived from the amount of time given as the SOA.

As discussed above, the probe (visual display) will trigger a specific oscillatory pattern in the brain;
it is vital that this pattern be constrained within the correct timing of the SOA in order for quick
judgments to made regarding the displayed probes. As such, the aforementioned experiments
delineated the SOA in which the required oscillatory pattern is triggered. This information will be
used for our future experiments when we look for a neural signature that should be present during
the SOA and is indicative of priming benefits on the enhancement of visual recognition.
Sources Cited


How Virtual Reality became a form of Treatment for Acrophobia

Denise G. Peralta

Abstract

This paper looks at three published articles about the impact that virtual reality (VR) technology has on treating people who are afraid of heights. The articles do vary in the applications of the virtual reality technology, but they all link when the discussion to train people to have postural control follows through. Also, this paper links actual VR experience, which gives further insight on the significance and highly effective VR technology is. The purpose of this paper is to look into how VR became a useful technology in treating acrophobia.

Keywords: acrophobia, virtual reality, treatment

Acrophobia is an extreme fear of heights. Acrophobic people tend to feel impaired and restricted in their movements and as a result they avoid height related circumstances (Coelho et al., 2010). There have been many studies done with acrophobic people to try and understand when and why acrophobia is developed, and how to get rid of it, so to speak. Virtual reality (VR) technology has been used to treat many phobias including acrophobia, and many studies have shown that virtual reality exposure therapy (VRET) has been one of the best leading therapies to treat acrophobia (Coelho et al., 2009). By following along with experiments on how researchers have managed to diminish and in some cases rid people of their acrophobia we may see how VR is used as a treatment for acrophobia to understand why it is considered a highly effective form of treatment especially in cases of improving postural control.
There are multiple factors that researchers believe to be some reasons why acrophobia is developed. For instance, there is a case of non-associative accounts, which is when individuals who have fear of heights are unable to clearly recollect a “height-related aversive experience” (Coelho et al., 2009). There was a longitudinal study done by Poulton et al. (1998) who found that people who suffered from serious injuries from falls between the ages of five to nine were the participants who had no fear of heights (Coelho et al., 2009). Meanwhile, those who do have a fear of heights are the participants who do not have a history of serious injuries from falls that occurred before they were nine years old. Moreover, since the people who do not have a fear of heights suffered serious injuries before nine years of age, this implies that their falls enabled to condition themselves with falling experiences, which gave them some sort of ability to have control over their body so they do not experience fear triggers when it comes to heights.

Another possible factor that may cause a development and maintenance of acrophobia are cognitive and biological issues. Acrophobia is said to have been developed like panic disorders and anxiety disorders, which lead to the thought that “cognitive biases may develop leading individuals to increasingly interpret bodily sensations that are tied to movement in height-related situations as threatening” (Coelho et al., 2009). Based on the cognitive and biological factors that are similar to panic disorders, acrophobics who have physical symptoms like dizziness, nausea, short of breath, or heart palpitations may cause them to overestimate the “danger” they might be in, and the negative feedback they receive from their bodily symptoms only reinforces their fear of heights (Coelho & Wallis 2010). Another reason why people may develop a fear of heights is because they do not feel in control of their balance. Thus, acrophobics may feel in control after they have been through a learning experience, which may be done by constantly exposing acrophobics to heights so that they may eventually develop “a remarkable degree of postural
balance” (Coelho et al., 2009). Following the idea that acrophobics may have poor balance control, especially for those who are visual dependent, may be related to heights vertigo because as objects move further away from people there is a reduction in motion parallax cues. Such depth cues are important because without them there may be “a perceptual conflict, as the vestibular and somatosensory receptors sense a body shift not detected by the visual system” (Coelho & Wallis 2010). Taking in all these possible explanations for why acrophobia may develop we could also see the importance of trying to figure out a way to help acrophobics get rid of their fear of heights, so that they may no longer feel restricted.

Researchers worked with acrophobic people to compare two methods of treatment, which were the exposure model and the self-efficacy model. The exposure model basically had acrophobic participants stare their fear right in the eye, so to speak. There were studies done with the exposure model with participants who were not afraid of heights and with acrophobic people, because it was theorized that acrophobia was a conditional response and by people avoiding heights the fear only got reinforced (Coelho et al., 2009). An experiment done by Wolpe (1958) had acrophobic participants “‘avoid’ avoidance,” and this technique became known as “systematic desensitization” (Coelho et al., 2009). Recall that one of the reasons behind the phobia of acrophobia is the emotional responses people get when put in an uncomfortable situation, which leads acrophobic people to interpret those emotional signals as life threatening, thus making them tens, dizzy, and simply become anxious. Therefore, Wolpe had his participants face their fears, but while facing them the participants were guided through a deep muscular relaxation. Wolpe believed that physical relaxation while facing a fear would work as “an anxiety antagonist,” which would eventually rid people of their fears (Coelho et al., 2009). After
taking into consideration Wolpe’s supportive results, many researchers worked on taking his findings a step further.

The other model theorized to help acrophobics get over their fear of heights was known as the self-efficacy model. The self-efficacy model was identified by Bandura, who “claimed that phobic behavior is influenced more by self-efficacy judgments than by outcome expectations” (Coelho et al., 2009). The self-efficacy treatment dealt more with the specifics of an individual’s phobia, and it was meant to enable the participants to feel in control and believe that they were able to do any task at hand. By the looks of the results, turns out that self-efficacy treatment turned out to be more effective than exposure treatment in the long run. Since participants were required to have a responsibility to themselves to personally track and help themselves to have better self-efficacy, thus when they stopped meeting with their therapist, these participants had trained themselves to continue the self-efficacy treatment (Coelho et al., 2009). There were also efficacy models that dealt with cognitive processes. There were multiple studies that linked faulty thinking with acrophobics discomfort and stress and as a result they suffered from the inability to deal with heights (Coelho et al., 2009). Then studies were followed by looking into the fact that some acrophobics tend to be more visually dependent, so they have the tendency to overestimate the danger of a fall the further way they move from the ground up (Coelho et al., 2009). However, there are still some acrophobics who are able to estimate the danger of a fall being very small, yet they still experience extreme fear of heights in general (Coelho et al., 2009). Thus, it became important to look more closely into bodily cues like postural control of acrophobics.
Note that the findings of the studies stated above were done using VR in the experiments because it enabled researchers to manipulate VR settings to look more closely into possible causes of acrophobia. Acrophobics tend to suffer from poor balance, thus indicating that they may have impaired vestibular, visual, proprioceptive, or somatosensory systems because these systems are essential for balance (Virk et al., 2006). VR is a cheap form of treatment that is able to replace the more dangerous treatment of the real outside environment, and it also gives participants more privacy since they are not required to leave the room for VR studies (Coelho et al., 2009). As used in Dr. Zili’s lab, VR also lessens the probability of getting seriously injured when working through balance exercise, especially when doing them on foam and with eyes closed. Linking some early findings of Chela Willey in Dr. Zili’s lab there were significant results found with non-acrophobic participants that when put into a VR setting with about an 18 degree tilt there are positive correlations between the tilt and the participants postural sway being biases toward the tilt, and this works the same for a negative tilt. Taking into consideration the biases of participants how have “normal” balance systems, it becomes easy to see why researchers believe that a reason why some people may suffer from acrophobia is because they lack the “effective control of motion and balance feedback” (Virk et al., 2006). By the end of the study of Virk et al (2006), participants with poor balance were trained with VR to “re-weight their sensory cues and to give less weight to the conflicting inputs,” which are results that could be applicable to help acrophobics manage their phobia and live less restricting lives.

Overall, there have been many experiments done with people who suffer from acrophobia to have found multiple treatments that have been successful in treating specific cases of acrophobia. Research to find the root cause or causes to acrophobia are still being conducted, since based on the reading above there are multiple possible factors that may develop
acrophobia. It is important to find the causes of acrophobia because it impairs its victims thus forcing them to live lives where they feel like they have no control over their own body movements. Thus far, VRET seems to have the leading role in training participants to regain control of their body, specifically their postural control, which is a significant step forward for deconstructing acrophobia.
References


Spacing and Category Learning

Elena Georgieva

Learning is an interesting and relevant topic that many researchers choose to study. The two papers discussed both analyze what it is like for learn concepts and categories. Kornell and Bjork (2008) study the effects of spacing on induction. Inductive reasoning is the process of learning something by observing specific instances of a concept or category. For example, in mathematics, a proof by induction involves checking every case: from the first to the n+1, and then generalizing the results. Many students and educators use induction in everyday lessons. Educators are interested in optimizing induction so students learn information quickly, and retain it accurately for a long period time.

It is an established fact in Psychology that material studied at a slow pace with breaks is recalled better in the long term than material “crammed” with no breaks. This is known as the spacing effect. Kornell and Bjork (2008) argue that spacing presentations of episodes or exemplars would make it difficult for one to notice specific characteristics that define that category. Meanwhile, massing these examples would make the characteristics of the category very obvious. The current study involved 120 undergraduate participants at the University of California at Los Angeles. Participants were shown 72 paintings by 12 different artists. The first group, experiment 1a, was shown half of the paintings presented consecutively and half presented with space between the presentations. The second group, experiment 1b, was randomly assigned to two conditions. Participants either saw all of the paintings massed or all spaced out. Next, there was a distractor task and participants indicated who they thought had created each painting, or selected “I don’t know.” Feedback was provided after each response, if correct the
participant was told they were correct, otherwise the correct artists name was presented. Group 1a was also asked whether massed or spaced learning was more helpful towards learning, or if they were around the same.

Results indicated that the advantage of spacing was significant in both experiment 1a and experiment 1b. There was also a significant interaction of presentation condition and test block. Finally, group 1a responded that they found massed learning more effective than spaced learning, while this was not the case. It is interesting that participants learned more when they felt they were learning less. Experiment 2 was designed to test recognition instead of recall. Participants were asked to categorize a painting as a “familiar artist” or “unfamiliar artist,” without requiring them to remember the artists’ names. Results showed that performance in the spaced condition was significantly better than performance in the massed condition. This was consistent with the first experiment.

Ultimately, these results show that interleaving paintings but different artists (spacing) was a more effective way to teach an artist than massing all of the artist’s paintings together. This is an interesting result that may not be intuitive. Interleaving paintings enhances discrimination learning, and similarly, being able to distinguish among the painted artists is being able to distinguish the group of artists from others. Clearly, spacing is beneficial for induction and likely for other types of learning. One possible reason for this is that spacing is a desirable difficulty. Sometimes when material is too easy to learn, it is difficult to retain. Therefore education should be focused on spacing and interleaving, especially when applied to inductive learning.
Kornell and Bjork (2008) left researchers with the question: is the advantage of spacing due to increased spacing between paintings of the same artists or different artists? Kang and Pashler (2012) chose to research the answer to this question. The purpose of their study was first to determine whether the positive spacing effects Kornell and Bjork found are due to temporal spacing or interleaving, and next to test if this spacing advantage is observed when one’s memory load is reduced.

In experiment 1, researchers had four conditions: the same massed and interleaved as Kornell and Bjork, as well as a condition featuring temporal spacing, and a condition in which the sequence of paintings was blocked by artists. This study only used three artists instead of 12. In the temporal spacing condition, the sequence of paintings was the same as that in the massed condition, except each was followed by a distractor task. In the simultaneous massed condition, paintings were presented four at a time for longer and they were blocked by artist. For example, all paintings in each set were by the same artist, and also multiple sets of paintings by the same artist were presented one after another. Afterwards, participants in all four conditions were shown a 20-minute distractor clip, followed by a test consisting of 48 new paintings by familiar artists. They were asked to click on the name of the artist. Unlike the Kornell and Bjork experiment, this experiment did not offer feedback to the participants, so they did not know whether their responses were correct or not. Results showed that performance in the interleaved condition was significantly higher than that in each of the other tree conditions. The differences between the other conditions were not significant. Clearly, interleaved presentation of materials is better for learning, especially in situations where the memory load is low. In this study participants had a lesser need to remember pairings between category labels and paintings. These results support and expand on Kornell and Bjork’s (2008) results.
In experiment 2, researchers included a condition that simultaneously presented paintings by different artists. This should enhance induction learning as much as interleaving does. This was called the simultaneous different condition, and results did not show a significant difference. This provides additional support for the idea that inductive learning is facilitated when presentations are interleaved or when different artists’ paintings are shown simultaneously. Therefore, the spacing advantage is due to the interleaving of artists’ paintings—not the temporal spacing as researchers originally hypothesized.

These results can be applied to education. When students are studying information, it is important to vary the category of information studied. For example, instead of studying information about the revolutionary war then studying information about the civil war, students should intermix the material. In psychology classes such as Psych 120A, we are taught that spacing helps us retain information but we are not taught to intermix material. This is surprising information that is not intuitive and could make a difference in a student’s learning!

This was my first quarter working in the Bjork lab, and I look forward to returning next quarter. I have enjoyed working on the collector, and I want to continue doing so. Our Monday night meetings have been really helpful for me to get adjusted to the collector program and how to use it. I work a lot better in groups so if possible, I would like to meet in the lab a second time during the week to do work. Maybe just the undergraduates can meet to do the work we are assigned; that would absolutely make us more productive. Aside from the collector and weekly minifog meetings, I have not done much else in the lab. I would like to learn how the lab works, what current research is being done, and how I can help out! I want to be involved in the process
of creating original research, and I really want to present at a weekly minifog meeting. I actually really enjoy public speaking, and in order to give a presentation I have to understand the research 100%, and it’s always nice to be knowledgeable about an interesting subject. Finally, I want to learn more about graduate school, and I will make it my goal to talk to graduate student in the lab about their experiences.
Balance in Virtual Reality

Grace Ching

Balance is vital for daily activities such as walking and remaining upright. Without a good sense of balance, one may fall and become severely injured. The central nervous system prevents this and maintains balance of the body through a number of sensory inputs: vision, vestibular, proprioceptive, and somatosensory inputs (Virk & McConville, 2006). When cues are missing, or a cue is skewed, the central nervous system adapts and relies less on those cues (Virk & McConville, 2006). In order to investigate this, some researchers implement studies using virtual reality including Chela Willey from the Zili Lab at University of California, Los Angeles.

The different inputs all provide various pieces of information that give insight to the environment and help the body maintain balance. The visual cues give information about the position and motion of the head based on the environment, the vestibular cues signal the motion and position of the head in space, detecting angular acceleration of the head (Virk & McConville, 2006). The proprioceptive and somatosensory system provide information about the positions of the limbs and to sense the tactile input stimuli at the neural level (Virk & McConville, 2006). Through virtual reality, these cues can be manipulated and examined individually. Virtual reality can even be used as therapy for people who have difficulty balancing or experience acrophobia (Virk & McConville, 2006; Coelho, Waters, & Wallis, 2009).

Exposure therapy in virtual reality has shown to be highly effective for treating acrophobia, or fear of heights as defined in the DSM IV (Coelho et al., 2009). Coelho et al. (2009) conducted a review of many papers analyzing acrophobia and treatments using virtual reality. Several articles found that people who suffered from a fall and had a painful experience
were more likely to not develop acrophobia, suggesting that exposure to heights or falling will help prevent the formation of acrophobia (Poulton & Menzies, 2002; Menzies & Parker, 2001). Studies have found a link that motion parallax and visuo-vestibular conflict play an important role in acrophobia (Coelho et al., 2009). Increased dependence on dynamic visual cues for controlling body stabilization may also play a key role in the predispositions to the development of acrophobia (Coelho et al., 2009). This link between acrophobia and balance is something that virtual reality can study because of its ability to recreate environments, separate and manipulate specific inputs, and study them independently (Coelho et al., 2009).

Virk & McConville (2006) and Coelho et al. (2009) both review past studies and further examine how virtual reality can be used for treatments for postural control and acrophobia. They found many past studies in which virtual reality has been found to be effective. Lamson (1994) used virtual reality to expose people who have acrophobia to simulated height situations and found that 90% of the participants were able to cope with their fear in reality immediately after and in a follow-up study 30 months later (Coelho et al., 2009). However, this study lacked rigorous analysis, so this is not reliable data (Coelho et al., 2009). Virk & McConville (2006) suggest applications of virtual reality that can train people to gain better postural control and avoid falling such as building more visual independence. Overall, these two studies are very hopeful for the future applications of virtual reality in this field and cite examples in the past in which virtual reality was successful.

However, Kelly, Riecke, Loomis, and Beall (2008) have found that visual control of posture in virtual environments does not directly reflect that of real environments. They conducted two experiments in which they manipulated the way in which participants viewed a
still, unmoving scene of a door. It was a within-subjects design with four manipulations of view: normal vision, normal vision with reduced field of view which is modeled after the reduced field of view in virtual reality, virtual reality, and virtual reality with no retinal flow. Both virtual reality views used head-mounted displays. There was another variable, vision, in which the participants either closed or opened their eyes. They compared the difference of the vision and the no vision conditions of each type of view. They found that people improved the most from vision to no vision when they had a normal view. They improved less when they had a reduced field of vision. However, they still improved more than in virtual reality, showing that the reduced field of vision partially mediated the difference of visual stabilization. They also had another condition in virtual reality where there was no retinal flow, or no correlated motion from one frame to the next. This was statistically the same as the normal virtual reality condition. In the next experiment, they added a condition where they reduced tracking latency by 63%. They also found no significant difference from the normal virtual reality condition. In the end, they found a significant difference between balancing in reality and balancing in virtual reality, partially mediated by reduced field of vision and not due to reduced latency or retinal flow. They also discussed other possible reasons for the differences between reality and virtual viewing, including display quantization in the head-mounted display, optical distortion, and added weight of the head-mounted display. However, the added weight was balanced and accounted for in the trials. Other studies have found no effects from the display quantization and optical distortion, leaving the definite cause of the differences undetermined.

This article’s key results are that visual stabilization improves more in reality than in virtual reality and that the cause is still undetermined but partially explained by the limited field of vision. However, in order to test the effect of tracking latency, Kelly, Riecke, Loomis, and
Beall (2008) reduced the it by 63% instead of increasing it, which seems to be a more natural problem in computer programs. Perhaps increasing the tracking latency, or lag time, will better explain the possible effects of tracking latency because it more accurately reflects issues that computers may have. The sample size was also very small: eight participants for the first and second experiment. Nonetheless, this article makes a very important point: data found in virtual reality may not necessarily reflect that of reality. The human brain seems to process the information from virtual reality differently than reality, which leads to worse visual stabilization. Further research is also needed to clearly establish the factor or factors that lead to the difference of visual stabilization between reality and virtual reality. Perhaps the knowledge of being in virtual reality unconsciously makes the visual information less reliable, and the participants rely on it less, leading to a smaller difference between using virtual reality and eyed closed.

In the Zili Lab at the University of California, Los Angeles, Chela Willey is working on a project studying balance through the use of virtual reality. In this project, she created seven rooms in virtual reality with furniture to increase the participants’ immersion. These rooms are identical except for the y-tilt in the room which are 0, -8°, 8°, -18°, 18°, -28°, 28°, -38°, and 38°. Participants wore accelerometers on their head, right arm, and waist to measure their standing sway. They wore the oculus rift development kit 1 on their heads to view the virtual rooms. They stood with arms crossed, and feet lined up with the left foot in front of the right. They stood looking at the back of the room for one minute and forty seconds. In addition to this, their balance outside of virtual reality was measured. Data was also collected from four conditions in which they are outside of virtual reality, standing on flat ground and foam, with eyes open and closed. After this, the participants were given a subjective vertical test in the same virtual rooms.
They were presented a rod with randomized starting positions of -15° and 15°, and asked to ignore the tilt of the rooms and turn the rods until they believed the rods were straight in reality.

This experiment is currently still in progress, but the hypothesis that a participant’s balance would be correlated with their error in the subjective vertical is supported in the preliminary results of the first seven participants. The data appears to show a correlation between how much the participants swayed while on the foam and the amount of error they had in the subjective vertical test. Because of the age of the participants who are college students, there was no correlation between their ability to balance without the foam and their subjective vertical test. To the participants who are undergraduates, aged 19-23, the balancing task without foam is not very difficult, so all participants did well, which resulted in a ceiling effect and no correlation. After this, additional rooms without furniture but with identical tilts will be created to measure the influence of immersion and richness of the environment. The subjects will use these rooms for the subjective vertical test. In addition, the vestibular input will also be manipulated to test its effect on the subjective vertical test.

Because this experiment is still being piloted on members of the Zili Lab, the sample size is limited. However, as the experiment progresses, the participants will eventually be gathered from a pool of psychology students at University of California, Los Angeles. After this, the participant pool will expand to those in an older population, who will most likely have more difficulty with the balancing task and show correlation between their subjective vertical task and their balancing task without the foam.
References


Social Contract Theory and the Wason Test

Hann Lam Woo

This paper uses aims to shed light on adaptive specialization and social contract theory and how the social contract theory can be studied using a Wason test. Adaptive specialization is a set of expert systems with unique problem solving algorithms which evolves based on the changes in the corresponding problem domain. Social exchange theory is defined by Cosmides et al. (2010) as “a task analysis specifying what computational properties a neurocognitive system would need to generate adaptive interferences and behavior in social exchange problem domain”.

Cosmides states that human intelligence is able to trump current machine intelligence because of the ability of the human mind to gain adaptive specialization. Cosmides et al. also theorizes that the human mind develops social contract algorithms, “a set of programs built by natural selection for reasoning about social exchange”. These systems are built in the human mind to help humans gain the most benefit and less risk in any situation. For this quarter, my research has been focusing on understanding social contract theory and how it can be tested using a Wason test. The Wason test usually consists of a background story, a rule and four cards, each card having two sides. Social contract theory can be tested by modifying the background story and the rule and observe subject performance on the specific task.

There are 2 main conditions that are being observed in this study: Hazard Management theory and Social Contract theory. For the Hazard Management theory condition, there are two factors that contribute to this condition: presence of a hazard and the efficient precaution. The hypothesis for this condition is subjects will perform better if the background story has a hazard present and that the precaution that can be take is effective. Presence of hazard in the background
story could be a story which concerns life and death, such as a poisonous spider which venom will kill you if you get stung. An efficient precaution would be a precaution that would help mitigate the risk of the hazard, such as an effective antivenom against the spider’s venom.

As for the Social Contract condition, there are three factors which are being manipulated in this study: presence of a benefit, the possibility for someone to cheat and the intention of breaking the rule. Cosmides et al. (2010) has provided a good example to understand this condition. Imagine that a school has parent volunteers to help them sort high school applications and delegate them to specific high schools. The potential benefit from this situation is that parents may try to place their child to a better high school. There would be a possibility for parents to cheat if there are no strict regulations that are put in place to prevent them from assigning their own child to better high schools, taking the place of other deserving applicants. Intention to cheat can be identified if there are rumors of parents who are trying to break the rule and assign their own children to better high schools. It is hypothesized that subjects would perform better if there is a benefit, no intention to cheat and no possibility of cheating. Below is an example of a Wason test which tests for social contract theory:

In another part of the universe, there is a world populated by Ents. An Ent is a giant talking tree which has a life span of a thousand years. Ents are social creatures which interact with each other to form communities. However, only one Ent can lead each tribe and a new leader is only elected when the current one passes away. The leader is selected by a council of elders who will give the potential candidates a special golden flower. A candidate would have total control of the Ent community for a period of one year to test their leadership skills. However, there are some
Ents who attempt to claim the candidate position by displaying a similar flower that they found in the forest and painted yellow. The candidate rule in the Ent community is:

“If you are a candidate, you must have an authentic golden flower.”

Imagine that you are a space traveler visiting this planet and the current leader has just passed away, and you are interested in whether the Ents obey this rule. Each card below represents an Ent. On one side it sells what flower they have, and on the other side it says what claims they are making about being a candidate.

Indicate which card(s), if any, must be turned over to find out if anyone has broken the candidate rule.

<table>
<thead>
<tr>
<th>Claims to be a candidate</th>
<th>Has an authentic golden flower</th>
<th>Does not claim to be a candidate</th>
<th>Does not have an authentic golden flower</th>
</tr>
</thead>
</table>

As seen from the example above, the benefit would be that the leader candidate is able to have total control of the Ent community for a period of one year to test their leadership skills. This also creates an intention to cheat, as Ents would try to cheat their way to gain the benefit of controlling the Ent community. It is possible for Ents to cheat by displaying a similar flower and painting the flower yellow.
There is a total of 12 different permutation of conditions including both Hazard Management Theory and Social Contract Theory. Subjects’ performance will be gauged by their ability to pick the correct card(s) to check to ensure that the given rule holds true. This study hypothesizes that subjects would perform better if they the situation is able to trigger either the subjects’ Hazard Management or Social Contract system. This study would help us either support or refute the claim by Cosmides et al. that humans are able to perform better because of the existence of these adaptive specializations.

Cheng and Holyoak (1985) developed the pragmatic reasoning schema, which is a different mechanism compared to the adaptive specializations that Cosmides et al. has proposed. The pragmatic reasoning schema is described by Cheng and Holyoak (1989) as “an abstract knowledge structure induced from ordinary life experiences, such as permission, obligations and causations”. Unlike the social exchange theory, the proposed schema is not based on the presence of benefit or the possibility to cheat, but a type of regulation that states that a particular action requires the satisfaction of a certain precondition. There has been a lot of back and forth criticism between both parties and as of today, and as of today, it is still difficult to identify which schema accurately represents how our minds work.
References


Flash-Lag Effect in Joint Localization of Biological Motion

Jiahui He

Abstract

Localizing a person in action and predicting their future position are crucial when we interact with others. Such localization and prediction often rely on joints of the moving body, but little is known about the mechanism of joint localization of biological motion. We adopted a paradigm based on flash-lag effect to investigate how body orientation (upright vs. inverted), types of reference joint (foot joint vs. hand joint) and walking sequence (forward vs. backward) influence joint localization. Experiment 1 investigated joint flash-lag effect in biological motion. A reference limb and joint were briefly flashed during a walking cycle of a skeleton, and participants perceived the joint lagging behind the limb when they were physically aligned. We also examined joint flash-lag effect in the absence of action perception (Experiment 2) and joint flash-lag effect in the absence of post-flash motion (Experiment 3). We found that the impact of body orientation depended on the importance of certain joint and walking sequence, and there was an inversion effect for foot joint when then in the forward walking condition. Joint localization was influenced by the importance of certain joints in action, such that foot joint was more important in joint localization when the walker was upright. When action perception was absent, the strength of flash-lag effect was reduced, suggesting that action-specific mechanisms were involved in joint localization. When there was no post-flash motion, no flash-lag effect was found. It demonstrated that post-flash motion had an impact on joint localization.

Keywords: flash-lag effect, joint localization, biological motion, action prediction
As humans are social beings, we highly interact with others and frequently deal with biological motion. In particular, when we interact with others, we often actively localize a person in action and predict their future position. For example, when receiving a book, you need to localize and predict the future position of the moving arm of the person who hands the book to you, so that you can adjust your arm to the corresponding position and grab the book precisely. But how does our visual system help us achieve such task? What is the underlying mechanism of moving joint localization of a body? We don’t have a defined answer yet. However, we can first refer to the studies of localization of moving objects as they may give us some insights. Researchers found that people perceive the flashed stimulus to be lagging behind a moving stimulus when the flashed stimulus and the moving stimulus are exactly aligned (Nijhawan, 1994).

The phenomenon described above is known as the flash lag effect (FL), and it has facilitated the studies of localization of moving objects for decades. Different theories had been proposed to explain why we have such illusion. According to temporal integration, or temporal averaging (Krekelberg & Lappe, 2000), in order to determine the position of a moving object, incoming data of the moving object are averaged or sampled over some period of time. The flash requests the calculation of the position of the moving object, and this requires some time after the flash has happened. Thus, the perceived position of the moving object reflects an averaged position based on the post-flash trajectory. Later, Eagleman and Sejnowski (2000) extended temporal averaging to a more general concept--postdiction. Their experiments indicated that the pre-flashed trajectory was independent from the illusory displacement between flashed and moving stimuli. The degree of misperception was the same even when the flash happened at different times before the moving object occurred. In contrast, such illusory displacement
entirely depended on the post-flash movement because different post-flash motions (continue, stop and reverse) produced different degree of misperception. They concluded that the flash resets motion integration, and motion is re-calculated and postdicted to the time of the flash.

The studies of predicting biological motion from Graf et al. (2007) is also worth mentioning. They motion-captured human actions and rendered them as point-light action sequences. Participants perceived short videos of these actions, then an occluder and the static test posture. The occluder time and the movement gap (the time between the end of the action and the test posture) were varied indecently. Result showed that when the test posture was a continuation of the action sequence that corresponded to the occluder time, participants had successful prediction. This suggested that visual system incorporates a real-time action simulation process in action prediction.

Compared to simple object movements, biological motion is a lot more complex. Thus, when studying the joint localization of biological motion, we should also consider the effect of body orientation. Simion, Regolin and Bulf (2008) presented newborn babies (age range: 17–88 h) with upright or inverted point light displays of walking hen. The result was that newborns looked significantly longer at upright displays than upside-down displays and indicated that biological motion perception has orientation specificity. Another factor that we concerned was the importance of the movements of foot joints. The research from van Boxtel and Lu (2015) demonstrated that when discriminating bipedal actions such as walking and running, movements of foot joints are more important than movements of hand joints. In the current study, we examined the effects of body orientation and different joints on joint localization. Based on the findings of previous studies, we hypothesized that inverted walker would elicit weaker FL than upright walker. We also expected that foot joints would induce stronger FL than hand joint.
Method

Experiment 1 investigated joint flash-lag effect in biological motion. The experiment had three within-subject factors: body orientation (upright vs. inverted), walking sequence (forward vs. backward), and type of reference joint (hand vs. foot). We also had two between-subject counterbalancing factors, the order of blocks and facing orientation. Body orientation and walking sequence generated four kinds of blocks for each participant. There were 280 trials in each block (2 joints x 7 offset levels x 20 trials per condition). The stimulus was a skeleton walker which had eight segments with two hands and two feet (see Figure 1). One arm and the lower leg of the opposite side of the body were red (these two red limbs were reference limbs), and the rest of the skeleton was grey. In each trial, the walker was in the center of the screen and completed one walking cycle which included 60 frames and lasted one second. A green dot and one of the red limbs (either hand or foot, and it was randomized within each block) were briefly flashed during the waking cycle of the skeleton. Only the green dot and one red limb were displayed during the flash, and the skeleton would re-appear and continued its waking cycle after the flash. The green dot always appeared at the same physical location, but the time of flashing the green dot and red limb varied, and the green dot would be behind, aligned with, or ahead the red limb. We had seven offset levels to simulate a psychometrics curve. Participants were asked to judge whether the green dot was on the left side or right side of the nearby red limb. The strength of flash lag effect was measured in terms of the perceived temporal lag of the point of subjective equality (PSE). Between trials, there was a cross-fixation in the center of the screen. Participants were instructed to look at the cross-fixation to help them pay their attention to the center of the screen.
Experiment 2 aimed to test joint flash lag effect in biological motion when action perception was absent. Experiment 2 replicated the method of Experiment 1, except only one red arm and the lower red leg of the opposite side of the body (these two limbs were defined as reference limbs) were shown (see Figure 2).

Experiment 3 investigated joint flash lag effect when there was no moving action after the flash. Experiment 3 also adopted the method of experiment. Different from Experiment 1, one independent variable—walking sequence was removed and the experiment only had two blocks. Also, the skeleton would disappear and ended its waking cycle after the flash (see Figure 3).

**Results**

The result of Experiment 1 (Figure 4) showed that the strength of flash lag effect of foot joint was significantly stronger in the upright walker than the inverted walker in the forward walking condition. But such a difference was not observed when the action was unfamiliar (the backward walking). Body orientation and walking sequence had main effects on the strength of flash lag effect for hand joint, such that the strength of FL was stronger in the forward walking condition than the backward walking condition, and the strength of FL was stronger when the walker was upright than when the walker was inverted. The strength of FL was stronger for foot joint than hand joint when the walker was upright, regardless the walking sequence.

The analysis of Experiment 2 (Figure 5) indicated that the strength of FL was significantly reduced compared to the strength of FL in Experiment 1. There was no main effect of body orientation.

As shown in Figure 6, the perceived temporal lag of the point of subjective equality (PSE) was negative for all conditions of Experiment 3 which indicated that participants did not
experience FL. There was only a main effect of joint, and the strength of motion-induced bias was stronger for foot joint than for hand joint.

**Discussion**

In general, these experiments demonstrate that how multiple factors influence joint localization in biological motion. In Experiment 1, the impact of body orientation depended on the type of reference joint and the walking sequence. We found inversion effect for the foot joint in the forward walking condition. Inversion effect means that people are less accurate when recognizing inverted stimulus such as inverted faces. In the current experiment, we refer to the strength of flash-lag effect was much weaker when the walker was inverted. We are not able to find inversion effect for the hand joint in forward walking condition and we observe an opposite pattern, such that the inverted walker induced stronger FL than the upright walker. This difference may be explained by a spatial attention preference for the closer-to ground body parts in bipedal action (Troje & Westhoff, 2006). When the walker was inverted, hand joints were in relatively lower position than foot joints. The impact of body orientation on the strength of flash-lag effect is not found in the backward walking condition. Perhaps it is because backward walking is less familiar than forward walking to us and unfamiliar action is less predictive as suggested by the previous study (Graf et. al, 2007). Furthermore, we found that joint localization was influenced by the importance of certain joints in action. In Experiment 1, the strength of FL was stronger for foot joint than hand joint when the walker was upright, regardless the walking sequence. This result is consistent with Troje and Westhoff’s finding (2006) that the informative cues from foot movement play a role as a life-detector.

The result from Experiment 2 provides more evidence that the impact of body orientation on the FL is a signature of action prediction. When the walker was not presented in a whole and
action perception was absent, body orientation had no impact on the strength of FL. This suggests that the difference in the FL between the upright and inverted conditions in Experiment 1 was driven by predictive processing in action perception. Also, when action perception was absent, the strength of FL was significantly reduced, suggesting that action-specific mechanisms were involved in joint localization.

The purpose of running Experiment 3 was to examine whether participants ran real-time action stimulation in joint localization. When post-flash motion was absent, participants did not experience FL, which indicated that they did not run real-time action stimulation. Compared the results of Experiment 3 to the result of Experiment 1, it is clear that the post-flash motions (continuation or discontinuation of the motion) influence joint localization of biological motion. When there was motion after the flash, FL was detected; when there was no motion after the flash, no FL was found. This result supports the postdiction theory (Eagleman & Sejnowski, 2000). But why was the perceived temporal lag of the point of subjective equality (PSE) negative in Experiment 3? The study of flash grab effect in object movement (Cavanagh & Anstis, 2013) also found negative degree of perceived position shift. Nevertheless, the post-motion in their experiment was reverse which was different from ours. Perhaps it is because biological is a lot more complex than object movement as mentioned and the context of the movement matters. Future experiments are needed to fully study this phenomenon.

References


Figure 1. Stimulus illustration for Experiment 1. One arm and the lower leg of the opposite side of the body were red (these two red limbs were reference limbs). A green dot and a reference limb were flashed during the walking cycle of the skeleton. The green dot was flashed at different time points of the walking cycle, and was physically behind, aligned with and head of reference limb (leg in this present example).
Figure 2. Illustration of the display used in Experiment 2. Only reference limbs were shown instead of a whole body. The green dot was flashed at different time points of the walking cycle, and was physically behind, aligned with and head of reference limb.

Figure 3. Illustration of the display used in Experiment 3. The green dot was flashed at different time points of the walking cycle, and was physically behind, aligned with and head of reference limb. The skeleton disappeared after the flash appeared.

Figure 4. Results for joint FL effect in Experiment 1. The strength of FL in terms of the
perceived spatial lag of PSE varied depending on body orientation (upright vs. inverted), walking sequence (forward vs. backward) and reference joints (foot vs. hand).

*Figure 5.* Results of joint FL effect from Experiment 2. The strength of FL was significantly weaken and was not influenced by body orientation when action perception was absent.

*Figure 6.* Results for joint FL effect in Experiment 3. The strength of motion-induced position bias in terms of the perceived spacial temporal lag of PSE varied depending on reference joints (foot vs. hand).
Effects of tDCS on Reasoning, Perception, and Memory

Kishan Dahya

Transcranial Direct Current Stimulation (tDCS) is a non-invasive brain stimulation technique that can be applied at a low-voltage using electrodes to small areas of interest in the brain. While not conclusive, recent studies have shown that Transcranial Direct Current Stimulation may be able to improve cognitive function in healthy individuals. Additionally, it has also been used in research to test its effects on psychiatric disorders, most notably depression. This quarter, I helped conduct Andrew Westphal’s tDCS study as a research assistant for the Rissman Memory Lab. My work for the lab included mostly scheduling and running participants through the experiment. The goal of his study is to identify if application of tDCS affects participant performance on tasks such as episodic memory retrieval, analogical reasoning, and visuospatial learning. Thus, he is examining the effects of tDCS on certain cognitive functions and how they may be applied in future.

Transcranial Direct Current Stimulation stimulation works by attaching two electrodes, the cathode and the anode, to the scalp and running a low-voltage current through them to the targeted brain region. Excitability of neurons in the target region are meant to increase near the anode and decrease near the cathode. Thus, tDCS may affect our brain functions by increasing or decreasing brain stimulation and cognitive abilities in a specific target area (de Berker et al., 2013). In the tDCS study for the lab, we apply the electrodes to the right motor cortex and left rostrolateral prefrontal cortex (RLPFC). Depending on the condition, the anode is either near the RLPFC or the cathode is near the RLPFC so that both increased excitability of the RLPFC and decreased excitability of the RLPFC are measured.
Some research has suggested that tDCS can modulate cognitive abilities while others are more skeptical of tDCS’ effects. While some studies have found modulation in cognitive abilities, it is difficult to conclude exactly that tDCS was the reason for modulation because there are so many different cognitive functions in a given area of the brain. Furthermore, while tDCS is applied to a specific area, function in other parts of the brain that are not being analyzed can also be excited introducing another extraneous variable into a study that needs to be accounted for. Thus, in order to properly interpret the effects of tDCS on cognitive abilities, clear a priori hypotheses along with careful technical analyses are needed. Some consideration also needs to be given to the fact that behavioral effects could be affected by modulation in parallel parts of the brain for related functions further complicating the interpretation of tDCS’ effects on a specific brain region (Tremblay et al. 2014). As Tremblay’s article suggests, the effects of tDCS on cognitive abilities is a debated subject and there is no clear, overwhelming evidence that tDCS does or does not increase cognitive function.

Other research has also found that tDCS has some capacity to increase learning and cognitive functions that could be combined with cognitive training (CT) to produce enhanced therapeutic interventions. Donel Martin and his team previously showed that tDCS could enhance performance accuracy on a working memory CT task over repeated sessions but found that tDCS did not enhance skill acquisition. Later, they investigated the optimal timing for combining both tDCS and CT task to enhance skill acquisition. After running their experiment and conduct the analysis, the found that tDCS in the ‘online’ position was associated with better skill acquisition on the CT task providing evidence for tDCS beneficial effects on abilities (Martin et al., 2014). The study I am helping conduct in the Rissman lab explores how tDCS may help increase participant cognitive function in the realms of episodic memory, analogical
reasoning, and visuospatial learning. Our results may be able to provide more information about the effects of tDCS and help resolve some of the controversy surrounding it.

The tDCS experiment takes place over two days, Day One and Day Two. The first day is mostly familiarizing the participant with the experiment without any tDCS done while the second day is comprised of eight runs of the RPM task with the tDCS applied. There are three conditions to which participants are randomly assigned. For all three conditions, however, the first four runs are done in the sham setting of tDCS while the next four differ depending on the condition. The last four trials in Condition 1 are also done in sham setting making that condition sham-sham. The second setting in Condition 2 is anodal stimulation of the left rostrolateral prefrontal cortex (RLPFC) making that condition sham-anode. And the third condition is cathodal stimulation of the left RLPFC making that condition sham-cathode.

Overall, the experiment takes about three hours over the course of two consecutive days. The first day usually takes about an hour while the second takes about two hours. My function was to come in and help prepare the participant for the Day Two tasks on Day One. I am not currently allowed to administer the tDCS on participants, so I do not have any experience running the second day of the experiment, but I have observed it multiple times. I am, however, allowed to do Day One of the experiment on my own where we train the participant on the tasks and allow them to become comfortable enough with the protocol for testing the following day. To do this, I would explain the procedure to them, read the directions, and answer any questions that the participants may have had. The participants would also undergo a button-mapping task and a memory encoding session during the first day.

A typical Day one would begin with me giving the participants the proper forms to fill out and going through the IRB protocol. I would then answer any questions the participant may
have. Next, I would open up a PowerPoint presentation that we use in order to explain the task to the participants and explain both the memory encoding task and the button-mapping task. Then, I would explain the reasoning, perception, and memory (RPM) tasks and what each entailed.

The memory encoding task was the first thing I explained in the procedure. I made it clear to the participants that the words they would be encoding during this task would be the words that they are tested on in Day Two. Participants were given a context of either “Self” or “Other” and then given a word to associate with that context and remember. They were instructed to encode the memory by creating or remembering some sort of story about it in their mind. For example, if the screen flashed the context of “Self” and then the word “Pie,” the participant was to create some sort of memory relating pie to themselves such as eating the last piece of pumpkin pie on Thanksgiving. After explaining the memory-encoding task, I explained the button-mapping task. The goal of that task was to prepare the participants for the proper responses to each of the four RPM tasks. Because the answer choices change for each of the three tasks used in this experiment, it is essential that participants are able to accurately answer their thoughts for each of the tasks.

Next, I began to explain the actual instructions of the RPM tasks starting with reasoning. In the reasoning task, participants are asked to judge whether two word-pairs presented on the screen share the same abstract relationship. There were four types of relationships used in this study: valid analogical relationship, two valid semantic relationship, one valid semantic relationship, and no semantic relationship. A valid analogical relationship is one in which both word pairs are semantically related to each other and both word pairs are related in the same way. For example, one pair may be “Apple” and “Fruit” while the other is “Fern” and “Plant.” These two pairs are classified as a valid analogical relationship because apple and fern are
semantically related to fruit and plant in the same way because both are members (apple and fern) of a larger category (fruit and plant). For a two valid semantic relationship, both word pairs need to be semantically related but not have the same relationship. For example, “Flag” and “Country” and “Fork” and “Utensil” are word pairs that classify as two valid semantic relationships since they relate to each other but in different ways - a fork is a type of utensil while a flag represents a country. A one valid semantic relationship has one word pair that is semantically related while the other is not. For example, “Juice” and “Liquid” and “Computer” and “Spaghetti.” The first word pair is semantically related while the second one is not. The last type is that both word pairs have no semantic relationship such as “Zipper” and “Toe” and “Ball” and “Church.” After explaining each option they may see, I asked participants if they had any questions and asked them to provide examples of their own to informally test their understanding.

After finishing the explanation of the reasoning task, I would explain the Perception task to the participants. In this task, participants were shown four words, one in each corner of the screen, and had to make a judgement on which contained the greatest number of straight lines. The words are only flashed for a few seconds, so the participant does not have time to count the exact number but has to rely on perception to make a decision. Straight lines can be in any orientation, diagonal, vertical or horizontal, and can also have a hook at the end. For example, the letter “j” has one vertical line. Some other examples we provided the participants with were “k” which has three straights line, “e” with one straight line, “w” with four straight lines” and “u” with two straight lines. After explaining that task, I asked if the participant had any questions and answered them before moving on.
The final task I explained was the memory task. The goal of the memory task was for the participant to identify if any of the four words on screen had been previously encountered during the memory encoding task described earlier and the degree to which they remember the contextual details of that word. Each trial would have four words shown on the screen and either one of the four words would have been previously encountered or all of them were novel to the participant. Thus, there were four answer options for every trial. The first was recollecting one of the four words from the memory encoding task in the “Self” context, the next was recollecting a word from the memory encoding task in the “Other” context, third was recollecting the word but not remembering the context specified, and the fourth was not recognizing any of the words as previously encountered. The participants were instructed to only attempt to specify the context if they were confident in their recollection of the source which is why there is an option for them to answer that they believe they have encountered the word but cannot remember the specific context. I then asked the participants if they had any questions and answered them as best I could.

After the participants had the entire experiment explained to them, they were shown a simulation of what the study would look like just so they could get a sense of the timing and task demands. Next, I began the actual MATLAB program in training mode so that the participant could undergo the button-mapping training, the memory-encoding task and one trial run of the RPM task.

The RPM task was in random order meaning that one of the three letters was flashed before the words were shown corresponding the the task it represented. Depending on the task at hand, participants had to use different responses so it was of utmost importance that they underwent successful button mapping training to answer clearly. If the participant did mess up,
they were informed that only the initial button press is recorded and so nothing can be done except to move on. Because of that fact, participants were also told to be careful with their responses and to only make their response when they believe they have the correct answer. At the end of Day One, participants one trial of the RPM task that they will do eight of on Day Two.

Usually the full length of Day One is about an hour after which the participant is reminded of their appointment the next day and told to refrain from heavy drinking, drug use and hair products that can affect the application of tDCS. On Day Two, the participants are fitted with the tDCS and depending on their condition receive cathode stimulation, anode stimulation or no stimulation. As mentioned earlier, all three condition begin with sham stimulation for the first four trials of the RPM task. After four trials, however, there is a rest task for the participant at which point the tDCS machine is switched from sham to stimulation depending on the condition.

Overall, my experience in lab in this quarter was positive. I learned a lot about tDCS and research methods involving human participants. I gained valuable experience conducting screenings, scheduling appointments and interacting with participants in a professional manner. The experiment has not come to a conclusion, and so I am currently still helping schedule and run participants of this study. I look forward to my continued efforts in this project and hope that they results turn out to be as significant and important to clearing up both the uses and issues of using tDCS to enhance memory, perception and reasoning.
References


Analyzing Priming effects in the perception of Biological Motion

Komel Choudry

Biological Motion is a term used by cognitive neuroscientists that refers to the unique visual movement of a moving, animate object. The stimuli that are usually used are small moving dots or lines that reflects the motion of the dots of key joints of a living, moving organism. Biological Motion is a key component for life. It is essential to perceive and understand the social interactions within an environment. Humans have the ability to recognize biological motion with poor visual input (the point-light display of representing human actions with distinct joints in a motion sequence). Determining how this phenomenon is done is still questioned by many researchers today.

I had the privilege to be a part of the Lu Lab which investigated in the how the brain implements biological motion. Our lab had recently projected a hierarchal system shown in figure 1 that proposed to be essential for how humans are able to depict biological motion. Levels structure the system; for example, the first level shows one part, a foot and the next level would show the foot attached with the leg and the last level would show the leg attached with the rest of the body. However, this structure lacks the finding on how our brain is able to interpret the middle steps. Our studies objective is to directly test whether the middle level motions are encoded, and whether the motion information is organized in a structural way.
Our study focused on the biological motion task. We had chosen to develop a model that was inspired by neural oscillations. There is a great comparison on non-invasive direct stimulation of the human brain, (rhythmic cranial magnetic stimulation-TMS), and on those frequencies that have the strongest behavioral impact (Thut & Miniussi 2009). Past research has found linkages between intrinsic brain oscillations to distinct sensory, motor and cognitive operations. This has been shown that brain rhythms are causally implicated in cognitive functions (Thut & Miniussi 2009). Studies have shown the importance of the rhythmic brain activity’s role in many cognitive functions. This is also related to the time-based dynamics of reaction time in psychophysical measurements. This study focuses on testing the time-based dynamics of the hierarchal motion structure representing human actions.

The experiment we are currently working on is a within subjects design because every participant performs the same experiment. Currently, we have participants come into the computer lab and perform the task on a computer on the MATLAB program. In each trial, after a 500ms fixation, participants view a brief motion of a prime stimulus, which is generated from a walking action of either walking forward or backward. The model illustrated in Figure 2 shows the six types of prime which is in accordance to the hierarchal motion structure, which is includes spatial coherent prime (i.e. two legs), motion coherent prime (i.e. one leg and one arm from opposite sides) and whole-body prime, in either the form of point-light or skeleton. We are comparing the priming effect of the incongruent and congruent response time and accuracy. The priming effect is a one dynamic motion stimulus that is seen before their true judgment of the walking direction.

**Figure 1**: A picture of the Hierarchal Structure of the walking action. Designed by Dr. Lu with the different colored dots showing cluster of joints which will be used in the prime and probe stimuli.
After the participants view the prime stimulus for a brief time, they instantly then see the probe, a point-light walking action, which is presented for 300 ms. Participants are asked to judge the probe’s action as accurately and quickly as possible. Only correct responses are recorded with accordance to fast response time. Response time is recorded as the time lag of the response since the appearance of the probe. The trial is labeled as correct when the walking direction is consistent with the probe, and the task is labeled as incorrect when the walking direction is inconsistent with the probe. To avoid the confounding variables of the walking directions, the facing directions (e.g. right or left) of the prime and probe is controlled to be the same in each trial.

In our main experiment we judged the forward and walking directions of the probe. As mentioned earlier in the design, we had two groups and six conditions. The two groups were congruent and incongruent and there were three conditions for each, making a total of six conditions. The three conditions were non-model, model, and whole body. Congruent and Incongruent prime and probe share similar properties. Congruent condition was operationally defined as the prime and probe walking in the same direction. Incongruent was operationally defined as the prime and probe walking in opposite directions.

Our results for response time for skeleton in the model congruent and incongruent was (642.16) and for the whole body it was (586.97) as shown in figure 3. The skeleton response time for model in congruent and incongruent showed a main effect and the whole body showed a significant main effect of (p>.05). The non-model showed a significant main effect as well. In the response time for the point light in model between congruent and incongruent was (642.16) and for whole body was (586.972) as shown in figure 4. The point light response time for model
did show a main effect, as did the non-model. The whole body seemed to show a significant main effect of (p>.05).

In our original hierarchy model, we had predicted that the model of one arm, one leg would lead to better walking direction judgment, but our results showed the opposite of this. It seems that the two legs lead to a larger priming effect than one arm and one leg. We were able to see this because the priming effect is the difference between these two conditions. We subtract the congruent non-model from the incongruent model or vice versa to get the priming effect in which our results showed. I believe this was an effective way of determining the priming effect. The difference is then shown in the height between the two bars in figures 3 and 4. Showing the motion of two legs was probably performed better than the original model of one arm and one leg because when only shown one arm and one leg, our brain then has to fill in the gap of what the motion of the other arm and other leg is. And sometimes, this can lead to an incorrect response. However, when participants are to judge two legs this may be easier, because they correlate the two legs immediately to walking and then can judge based on the way the two legs are facing and walking. In both the skeleton and the point light, the congruent response time was mostly accurate with a shorter response time than compared to the incongruent as shown in figures 3 and 4. The priming effect is of the very brief walker seen before the probe is either facilitating or inhibiting their later judgment. If congruent then this would facilitate their later judgment because the facing and walking direction would be the same. If incongruent, then this would inhibit their later judgment because the facing direction is opposite from the walking direction (Verfaillie 2000). This could probably be why the incongruent is not as effective as the congruent when comparing priming effects.
Another way to investigate the priming effects in biological motion is to experiment with the orientation of object display. Previous researches by Pavlova and Sokolov (2000) have found results in long-term priming effects with object rotations in biological motion. But, since our study in the lab is still ongoing I’m sure we will find more significant results that will allow us to understand even more into biological motion and priming effects.

My involvement in the study was to handle the experimental procedures. I was to log participant’s attendance in a data sheet and then to inform them of the experimental procedure. I guided the participants throughout the programming portion and explained the process in order for them to complete it as efficiently as possible. I also attended lab meetings to discuss the outcomes and future directions of experiments. I will be working in the lab for one more quarter and am eager to see the final results of this experiment, as well as other experiments.
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Figure 2. Experiment paradigm.

Figure 2. Diagrams of prime stimuli; six classes of prime motions are used. Each prime motion is either in the form on the point–light or skeleton. The three prime motions are spatial coherent prime, motion coherent prime and whole-body prime.
Figure 3: Graph shows the response time and accuracy of the skeleton which includes lines of the body parts shown in three different motion conditions; non-model, model and whole body-going from right to left.
Figure 4: Graph shows the response time and accuracy of the point-light which includes dots resembling joints of the body parts shown in three different motion conditions; non-model, model and whole body-going from right to left.
**Long Term Effects of Transcranial Direct Current Stimulation on NMDA Receptor**

Logan Barton-Rowledge

Research examining the effect of transcranial direct current stimulation (tDCS) and the applications of membrane potential modification continue to flourish. As a non-invasive brain stimulation technique, tDCS has become the primary method of low intensity direct-current stimulation due to the efficiency, low pain and non-invasiveness, and low cost. Placement of an active and reference electrode on the exterior of the head allows tDCS to electrically manipulate the resting membrane potential of cortical neurons in the region of interest causing a hyperpolarization or depolarization (cathodal and anodal stimulation, respectively) in the stimulated neural network. Anodal stimulation causes an increase in cortical excitability via subthreshold depolarization, which has been shown to facilitate language performance, perception, memory, as well as support therapy for post-stroke aphasia, depression, Alzheimer’s, and many others (Vestito et al.). The technique has yet to be vastly accepted due to its slight inadequacies in focalization and precision of stimulation. The majority of research in the past decade has been on the immediate and short-term effects of stimulation, most likely due to such promising results in the facilitation of neurological disorders and behavioral outcomes in the short term. However, emerging interest in the long-term effects of tDCS has opened the gate for the examination of the underlying neurophysiological mechanisms. The heavy involvement of N-methyl-D-aspartate receptors (NMDARs) in both healthy synaptic transmission and numerous neurological disorders, as well as NMDRs significant role in neural plastic functioning, has instigated research analyzing the influence of tDCS on the receptors and subsequently the role of tDCS facilitated long term potentiation (LTP) (Paoletti and Neyton).
Neuroplasticity consists of a reformation in synaptic strength, rewiring neural networks and thus allowing for robust cognitive adaptation to changing requirements and challenges. Long-term potentiation, a specific type of neural plasticity, highlights the long-term increase in the synaptic response of a given neuron. A well known factor that is vitally important in observing the elicited long term changes through LTP is the role of calcium in the postsynaptic cell and the creation of the calcium/calmodium complex, which will be discussed later on (Gnegy).

One of the primary mechanisms that regulates calcium ion levels is the activation of the glutamate NMDA receptor. The NMDAR is consequently named due to the fact that it is not only activated by glutamate and glycine (simultaneously), but also selectively activated by the amino acid agonist NMDA. Receptor activation causes the opening of its nonselective cation channel, which is particularly permeable to calcium ions, causing the NMDA receptor to be of crucial importance to structural and functional plasticity. However, postsynaptic reception of glutamate does not individually result in activation and calcium influx.

Thus, one of the primary challenges of NMDARs instigation of plastic effects arises in its indirectly voltage-sensitive activation. After an initial activation, the occlusion and sequential inhibition of the ion channel known as blocking can occur, inhibiting LTP. Positively charged elements, most commonly magnesium, act as a non-competitive antagonist by binding to the receptor instead of flowing through as the calcium does. This inhibition of the ion channel blocks the inward current flow of cations (Mayer et al.). Importantly, the mechanism of this blocking effect is dependent on negative membrane potential which causes the attraction of positive magnesium ions through the ion channel. At resting membrane potential, if the NMDAR pore
opens, magnesium enters the channel and creates this magnesium block. Once the channel is blocked, in order for the NMDAR to allow the transfer of the less electronegative sodium ions, and thus the potential for neural activation, a significant depolarization of the neuron must occur in order for magnesium block to be displaced (Seeburg et al). The intense depolarization necessary in order for the magnesium blockers to be dislodged can be achieved in a few ways, most commonly through high frequency of synaptic inputs. The unusual necessity for EPSPs and on a voltage-dependent ionotropic receptor is commonly observed in a behavioral sense, in which repetition of memory tasks causes longer lasting, higher accuracy memory retrieval.

Plasticity, particularly long term potentiation, is prompted by a cascade of mechanisms that are dependent on the presence of intracellular calcium binding with calmodium such as protein kinase II, adenylyl cyclase 1 and 8, and calcineurin. All of these physiological changes are part of signal transduction complexes associated with NMDRs (Xia and Strom).

Transcranial direct current stimulation has been found to enhance synaptic plasticity and LTP. Last year, scientists performed thirty minute 10mA and 25mA sessions on ex vivo hippocampal slices of rats and demonstrated a two-fold increase of LTP. As expected from other findings, they found a positive correlation between stimulation strength and its effect on synaptic plasticity, for 10mA and 25mA stimulations. They also tested the long-term effects of their stimulations as well as the addition of AP-5, an NDMA blocker. Their operational definition for long-term effects for rodents was a 24-hour interval period. Their results showed that the enhancement of LTP remained even after 24-hours, and the supplementation of AP-5 caused a termination of the LTP mechanisms (Rohan et al.). Extending the investigation onto human stimulation turns to a study conducted to analyze the long term benefits for patients suffering
from post-stroke aphasia. In 2014, a study placed subjects into one of two experimental groups, an anodal stimulation condition or a sham control group, and underwent stimulation for five days a week over a two week period. The overall research question being investigated was the effectiveness of the beneficial effects of anodal tDCS seen 21 weeks after the 10 stimulation sessions were conducted. The aphasic patients were given a set of 40 figures, depicting basic words of different levels of observation frequency (thus creating more or less difficulty to recall). The results of the study displayed an immediate benefit of the anodal stimulation directly prior to the sessions. Even more intriguing, the subjects who received anodal stimulation continued to show significant enhancement 16 weeks after the stimulation sessions, for all levels of recall difficulty. After the 16th week, a decline in naming performance was observed (Vestito et al.). Unfortunately, this study served as a pilot study given that only three subjects underwent the experiment. However, the results still show extreme promise of the long-term benefits of repeated anodal tDCS sessions.

Direct current stimulation is clearly well known and thoroughly analyzed for its ability to increase neuronal excitability during anodal tDCS due to subthreshold depolarizations. It has also been shown to directly enhance plastic effects such as LTP in humans through modulation of the NMDA receptor. Directly isolating for the effects of tDCS on ion channels and receptors, researchers at the University of Georg-August in Germany followed well established tDCS protocols to induce cortical excitation under a control study, but manipulated ion channel functioning through the administration of a NMDA receptor antagonist, dextromethorphan. Their results showed that the NMDA antagonist did not affect electric potential cortical enhancement. However, dextromethorphan did completely inhibit LTP induction and the longer lasting effect normally associated with anodal stimulation (Nitsche et al.). This illuminates the
expected, that calcium dependent functional cascades necessary for plastic changes are facilitated by the membrane depolarization, leading to a higher rate of calcium influx through the NMDA receptors.

In conclusion, it is evident that tDCS plays a significant role in both short-term and long-term cognitive facilitation. Depolarization of neural membranes displays well researched immediate cognitive enhancements due to cortical excitation which are capable of aiding in neural therapy for major depression, Alzheimer’s, schizophrenia, as well as many other cognitive disorders. Coupled with short term effects, research on direct current stimulation also indicates that due to the voltage-dependent mechanisms involved in the NMDA receptor, tDCS also proves to be a strong factor in enhancing neural plasticity by initiating neurophysiological cascades through the facilitating calcium influx through ion channels.
References


Using Cognitive Psychology to Study Smarter

Lora Dyakova

As students, one of our primary goals in school is to retain as much of the information we are presented with in class as possible. However, this becomes increasingly difficult to do when we take numerous simultaneous rigorous courses. How do we remember all of the necessary information? How can we prevent interference from competing information? Instead of studying harder, we can use cognitive psychology to study more effectively.

Ideally, the end goal of taking a college course should be to learn the information. Usually, the way to check whether or not a student has mastered the course material is by testing them on the content. Theoretically, if a student does well on a test, it must mean that he or she has learned the content. In reality, the situation is slightly more nuanced. Although a student who has actually learned the information will likely perform well on an exam, a student can perform well on an exam without having actually learned the information, at least not in the full sense of the word (Bjork & Bjork 2014). College students are notorious for cramming the night before a big test. Although this may be effective for passing tests, it is not conducive to long term learning. Cramming is an example of blocked learning – learning which occurs in one continuous interval. The antithesis to massed learning is spaced learning – learning which occurs over shorter intervals, spaced out over a period of time. In 2008, Kornell and Bjork decided to test whether blocked learning or interleaved learning led to better results. They had participants look at paintings by different artists and try to distinguish the artists’ styles. In some conditions, they were shown massed blocks of one artist’s work, whereas in others they were shown the target artist’s work interleaved between other artwork. Surprisingly, the interleaved group significantly outperformed the massed group (Kornell & Bjork 2008). This goes against what we
would intuitively expect. One would think that the massed condition would be more helpful
because in massed practice one is continuously exposed to the same style, so one can get a better
feel for that particular condition. In the case of artwork, one would think that seeing different
artists’ work interleaved among one another would make it harder to distinguish the different
pieces from one another. The subjects were asked to give a judgment of learning, and they too
largely thought that they were learning more in the massed condition than the interleaved
condition, even though their test results clearly indicated otherwise (Kornell & Bjork 2008). This
is somewhat concerning, as it indicates that we are not good judges of how we best learn.

We can apply the results of this study to our own study habits. Many of us may be
inclined to study one subject at a time, so as to avoid confusion. However, this experiment may
suggest that perhaps we will achieve better results by interleaving different subjects among one
another. Suppose it is Monday morning and one has three tests on Thursday – history,
mathematics, and psychology. Instead of studying history on Monday, followed by mathematics
on Tuesday, and then psychology on Wednesday, it may be beneficial to interleave these
subjects. For example, Monday could consist of 2 hours of history, followed by 2 hours of
mathematics, and then an additional 2 hours of psychology. On Tuesday, one can do something
similar, perhaps dedicating more time to one’s weakest subject, but still mixing in the other
subjects. This is precisely why cramming does not lead to long term learning – when one studies
all of the information at once, one misses out on the benefits of interleaving.

When studying, it can also be beneficial to introduce desirable difficulties. As the name
suggests, desirable difficulties make the study process harder. However, what separates desirable
difficulties from undesirable difficulties is the fact that the former strengthen the retrieval
process and lead to more learning in the long run, whereas undesirable difficulties do not have
any benefit (Bjork & Bjork 2014). One example of a desirable difficulty is varying the conditions of learning. Being exposed to the same information in different environments leads to increased learning in the long term. One possible explanation for this is that each time one encodes the target information, one is also encoding certain context clues in one’s environment. Later, when one encounters similar context clues, one is more likely to remember the information one needs. For example, let’s say a student studies for their psychology test over the course of three days. Each day, they go over the same information but in a different environment. On the first day, they are in a quiet room, well rested, and in a happy mood. On the second day, they are in a noisy room, tired, and in an angry mood. On the third day, they are in a quiet library, well rested, and in a sad mood. They have now practiced encoding the information under varying degrees of noise, tiredness, and mood. When they need to retrieve the information on the day of an exam, they will have more retrieval cues to use to their advantage than someone who only studied in a quiet room when they were happy and well rested. This is another reason why massed learning, like cramming for an exam in one night, is not ideal. During massed learning, one does not get the benefit of these varying conditions of learning. A student who crams for a test in one night will have less environmental retrieval cues than someone who has studied in various locations and in various moods.

This is not to say that a student who crams the night before an exam will necessarily do poorly on the exam. In fact, it is quite possible for him or her to perform well. In studies comparing performance between massed studying and spaced studying groups, both groups tend to do equally well on a test immediately following studying. The difference occurs when the final test is delayed. Thus, both a student who diligently studied the material for weeks leading up to the exam and a student who crammed the night before might get similar scores on an exam,
but if they had to take the same test one month later, the student who spaced their studying
would most likely remember much more than the student who crammed. This brings us back to
the distinction between performance and learning. If one’s only goal is to perform well on an
exam, then massed learning will be sufficient. However, if one truly wants to learn, in every
sense of the word, then one will need to retain the information, and spaced learning will enable
one to do this.

Another key phenomenon students should take advantage of is the testing effect. If given
the option, would it be more helpful to study by rereading the same information over and over
again or by reading the information once and then testing oneself? Many people instinctively
think that the former would be more helpful than the latter. Intuitively, one would think that
being exposed to the information repeatedly would make the information read more memorable.
Additionally, many students fear that if they test themselves and answer incorrectly, they will
later recall the incorrect information. However, research shows that this is not the case.

In 2009, Kornell, Hays, and Bjork conducted several experiments to test whether or not
pretesting would have an effect on final test performance. Although there were slight variations
between each experiment, in each one subjects were divided into two groups, a read-only group
and a test group. Both groups had to learn the same number of word pairs. The difference was
that the read-only group had the entire first block of time to study the pairs by trying to
memorize them, whereas the test group had to first guess what they thought the paired word
would be before they were shown the actual pair they were supposed to learn. Both groups were
then tested on all of the pairs once they had studied them all. Perhaps surprisingly, the test group
consistently outperformed the study group (Kornell, Hays, & Bjork 2009). It is worth noting that
when participants in the test condition made their guesses, they were usually incorrect. Yet,
despite being exposed to incorrect information (their original guess) and having less time to study the real pair, this group seemed to have an advantage over the study-only condition.

This challenges the idea of errorless learning, a belief which was long held to be the way to learn information (Kornell, Hays, & Bjork 2009). It has long been known that when one retrieves information, one strengthens the neural pathways to this information. This occurs regardless of whether or not the information is true. Thus, it was long feared that it would be detrimental to learning if one recalls incorrect information because this would strengthen the pathway to retrieving the incorrect information, making this false information more likely to be recalled at a later time (Little & Bjork 2011). However, newer research has shown that this concern is unnecessary, as long as one is shown the correct information soon after an initial incorrect guess. As long as one does get the correct answer, there is no danger in making an incorrect guess.

Students can apply the insight gained from these studies to their own study habits. Rather than just rereading the same information over and over again, one’s time may be better spent testing oneself on the material. Students may not feel inclined to engage in pretesting when they study, out of fear that they will confuse themselves with the wrong information during their initial guess. However, research suggests that as long as they correct themselves soon after making their initial incorrect guesses, they will be better off than if they had not tested themselves at all. Flashcards make effective study tools for precisely this reason. They allow students to quiz themselves, then give themselves feedback on whether or not they were accurate following their guess.

Students come to universities in pursuit of knowledge. As our classes get more difficult and the material we need to master piles up, we might feel overwhelmed at the idea of having to
learn it all. However, we would benefit to pay attention to the findings in the field of cognitive psychology in order to optimize the ways we study. Why study harder when we can use cognitive psychology to study smarter?
References


Models on Predicting Humans in Fluid Judgment

Raphael (Luxing) Wang

Abstract

Study examined human judgments on liquid under different viscosities and volumes. We found that human constantly employ rule-based reasoning when making the judgment on liquids. Several heuristics comply with the human results. When compare the human results to the computer model, we found the model generated using probabilistic simulation is superior than other models using machine learning. The study further speculate the mechanism within the human brain in solving such mental simulations.

Human brain is a fascinating organ due to its amazing capabilities: from the seemly infinite memory capacity to its computation of vague, less concrete questions. One would be amazed by the ability to simulate daily physical scenarios that artificial intelligence can't yet achieve. Study has found that human starts to develop the ability to simulate the orientation of the water surface at the age of 10 (Piaget & Inhelder 1956). When giving drawings of a tilted empty cup and ask subjects to indicate water line, subjects around age 10 started to reason the correct answer with the water line parallel to the imagined horizon. Subjects before age 10 tend to indicate a water line that is parallel to the bottom of the cup, which ignore the factor of gravity, suggesting they could not yet simulate daily physical encounters. Another similar study took the same question to adults of different occupations (McAfee & Proffitt 1991). They found that bartenders and waiters tend to get it "wrong"; they were more likely to indicate a waterline that is parallel to the bottom of the cup. While the rest of the subjects were more likely to indicate a waterline affected by the force of gravity, this study did not consider either response is right or wrong. The study speculated the frame of reference and its role in such experiment.
Waiters and bartenders gradually developed a frame of reference that is centered towards the object (the cup in this case), while the rest of the people have the frame of reference align with the gravity. They speculated that the altered frame of reference could help people with those occupations to better handle liquid in the cup or food in the container as they might experiment constant tilting. The third study, deviate from the previous two emphasize on the role of mental simulation (Schwartz & Black 1999). Subjects in the study were shown the image of two cups of the same heights but with one cup significantly wider than another. Both cups were filled with same level of water and the subjects' goal is to judge which water is going to pour first if tilting two cups simultaneously. In the initial test, only 34% of the subject correctly indicated that the wider cup is going to pour first. Then experimenter asked them to mentally rotate a cup, the success rate went up to 95%. This experiment did show the power of human brain in simulating everyday encounters.

The current study, inspired by previous three studies, has two levels of goals. The first level is to test human's judgment of liquid when some implicit attributes like the viscosity are added. Although attributes like volume and viscosity can be presented in a numerical measure precisely, people's perceived attribute might deviate from its true value and thus produce different responses. The second goal is trying to test different models in predicting human results. Some models were acquired through statistical analysis and machine learning and others utilized a probabilistic simulation to mimic human cognitive processes.

Methods

Participants
One hundred and fifty-two undergraduate students from University of California, Los Angeles (UCLA) who were enrolled in one of various psychology class participated through SONA - a psychology experiment management system for course credit. Subjects are filtered to ensure they understand English and do not process any prior psychological knowledge related to this study.

**Material and Design**

The goal of the study is to present subjects with two cups filled with color-coded liquid with high or low viscosity. The liquid could be ranging from 20% filled, 40% filled, 60% filled up to 80% filled. With two liquid each has four volume measures, subject will have to make judgment 16 pairs on which cup needs to be tilted further in order to pour out.

This current study will employ a 2X2 between subject design. With its first level of variable being the coloration of the liquid: either red liquid on the left at all times and green liquid on the right, or green liquid on the left and red liquid on the right. The second level of independent variable is the positioning of liquid with different viscosity: high viscosity liquid on the left and low viscosity liquid on the right or vice versa.

A video clip featuring an orange water pouring down from a point in the space and collide with two doughnut-shaped objects is used to offer the subjects an general impression of how liquid behave within the experiment. Another video clip with the same orange liquid is used, this time the orange liquid is contained in a transparent cup and there is an animation showing the cup tilting at a constant speed. The third video clip, much like the first video, will feature two liquid, one red and one green, pouring down from two points in the confined space into two doughnut-shaped objects respectively. Depending on which the condition subject is in, they might receive either high viscosity red liquid to the left, high viscosity green liquid to the
left, low viscosity red liquid to the left and low viscosity green liquid shown on the left. 16 graphs featuring two cups of liquid with different volumes are also prepared for subjects to make judgments, the sequence of the images was randomized to eliminate some potential biases.

**Procedure**

Subjects entered the room and the experimenter assigned them to each experiment cell according to condition number. Subjects then were instructed that they are about to make judgments of different fluid. The subject first watched a video showing liquid pouring down, this was just to offer subjects an general impression on how the liquid interact with other objects to show its physical character. Then they watched the same liquid contained in a cup and the cup was tilting using a constant speed. Subjects were instructed to maintain such tilting speed when doing the mental simulation in the later test period. There was a third video showing two different color coded liquid pouring down and subjects were told to remember the viscosity of each liquid. Then in the test period, subjects, after viewing images of two cups filled with different volume of the test liquid, need to make judgments on which liquid will need a further tilting angle (using the tilting speed as previously primed) for the contained liquid to pour out.

**Results**
The result of the study is plot in the graph included above. We first examine whether humans rely on rule-based reasoning to perform the viscous fluid-pouring task. One simple heuristic rule is that when the high viscosity and low viscosity liquid have the same volume, subjects should always should the high viscosity liquid to be poured later. The frequency of choosing high viscosity liquid to be poured later under 20% volume, 40% volume, 60% and 80% are 0.862 with standard error of 0.028, 0.842 with standard error of 0.030, 0.868 with the standard error of 0.028 and 0.849 with the standard error of 0.029 respectively. The second heuristic is that when high viscosity is under its lowest (20% volume), people should always reason that the high viscosity liquid would be poured out later. The result was promising and of the four pairs of judgments, over 86.2% of the subjects chose the correct answer.

Although as much important as human results, computer prediction modeling for the new data is still under the works.

**Discussion**

From the human results end, it appears that people reliably employ mental simulation strategies when performing our viscous fluid-pouring task. It could suggest that humans have a
mechanism to simulate physical information in the neural structure level. Although the modeling for the new data has not yet been completed, previous model, which fitted the human result, suggests that our model provides a solid explanation of behavioral results at the computational and representational levels. This indicates that our model, employing probabilistic simulation, is superior to other models that simply using machine learning or statistical analysis. But there is still a barrier between what our model is doing and the physical implementation by the human brain. Though the computer model might coincide with the human results, their underneath mechanism might still be different. Our model requires thousands of simulations to calculate an estimate, while it is unfeasible to assume that the human brain is doing the same. And perhaps our thoughts might be similar to a quantum state where the results is distributed in the time and space, and until you write it down, the thoughts in one’s brain might not be exact or certain.
Reference


Animated Sources and Demonstrations

Michelle Marsiske

Analogical thinking occurs when an individual uses information from one domain (the source) to help solve a problem in another domain (the target). Analogies can often be successfully employed in order to solve difficult problems. Interestingly, it is has been shown that experts of a given field have high rates of transfer, or the ability to recognize and employ analogies to solve problems, thus enabling them to solve difficult problems that novices often find impossible ("Psych 120A Cognitive Psychology: Knowledge").

One of the first researchers to study analogies and their use in problem solving was Karl Duncker. In order to study problem solving, Duncker devised multiple insight problems that necessitated that subjects restructure the initial representation of the problem. One of the most well known problems that Duncker devised is the radiation problem ("Cognitive Psychology: Analogy"). In this problem, subjects are told that:

“A doctor has a patient with a malignant tumor. The patient cannot be operated upon, but the doctor can use a particular type of ray to destroy the tumor. However, the ray will also destroy healthy tissue. At a lower intensity the rays would not damage the healthy tissue but would also not destroy the tumor.” ("Psych 120A Cognitive Psychology: Knowledge")

After receiving this prompt, Ducker asked participants what can be done in order to destroy the tumor. Due to the difficult nature of this insight problem, the solving rate was extremely low,
with only 10% of subjects gaining the insight necessary to answer the question ("Psych 120A Cognitive Psychology: Knowledge").

Nearly 30 years after being devised, Duncker’s radiation problem caught the attention of two researchers, Gick and Holyoak. “In two papers, Gick and Holyoak (1980 and 1983) explored the conditions under which participants would solve the radiation problem following exposure to an analogy” ("Cognitive Psychology: Analogy"). During their experiments, subjects were given the following analogy before being asked to solve the radiation problem:

“A small country was ruled from a strong fortress by a dictator. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads led to the fortress through the countryside. A rebel general vowed to capture the fortress. The general knew that an attack by his entire army would capture the fortress. He gathered his army at the head of one of the roads, ready to launch a full-scale direct attack. However, the general then learned that the dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator needed to move his troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road, but it would also destroy many neighboring villages. It therefore seemed impossible to capture the fortress. However, the general devised a simple plan. He divided his army into small groups and dispatched each group to the head of a different road. When all was ready he gave the signal and each group marched down a different road. Each group continued down its road to the fortress so that the entire army arrived together at the fortress at the same
time. In this way, the general captured the fortress and overthrew the dictator.” ("Psych 120A Cognitive Psychology: Knowledge")

Gick and Holyoak found that subjects were able to solve the radiation problem at a higher rate than Duncker’s subjects, with approximately 40% of participants solving the radiation problem with no further help after being given the analogy and an additional 40% solving it after they were told by researchers that the analogy was relevant to solving the radiation problem. Based on the results of their experiments, Gick and Holyoak concluded that analogies can successfully be employed to solve difficult problems ("Psych 120A Cognitive Psychology: Knowledge").

Due to analogies’ ability to increase problem solving, many educators are interested in integrating them into school curricula. In the past, analogies have been relayed in various formats such as text or by word of mouth. However, with the advancement of computer technology and graphics, an ever more common format is animation. Interestingly, over the last decade, researchers have found that animation yields to transfer rates higher than those of text-based or orally-based analogies. One experiment that supports this claim is Boom 47. In this experiment, participants were shown four scenarios in which one or multiple cannons fire at an enemy octagon surrounded by a friendly barrier with either small or large cannonballs. These scenarios were either animated (with verbal explanations) or simply verbal. Following this, participants either did or did not received source understanding questions. After a filler task, participants were asked to solve Duncker’s radiation problem without being told to apply the previously shown scenarios. Following being asked to answer the radiation problem on the first pass, participants were given the radiation problem again but with the suggestion to recall the previously observed scenarios. After analyzing the data, researchers found that animated source
instruction not only facilitated spontaneous analogical transfer during the first pass but also total or hinted analogical transfer during the second pass ("RA Research Manual"). Boom 47 is not the only recent study that found animation source instruction to be more successful than verbal only instruction. In 2009, Atkinson attempted to teach subjects how to solve word problems by incorporating an animated pedagogical agent. For the study, Atkinson ran two experiments. In Experiment 1, subjects were presented with either an agent delivering explanations orally (voice plus agent) or text (control). In Experiment 2, learners were presented with either an agent delivering explanations orally or with text based explanations. After analyzing the results, Atkinson found that subjects presented with an agent delivering explanations verbally outperformed their control peers on measures of transfer (Atkinson, 2009). Based on these two studies as well as many others, the general consensus among researchers is that animated sources and demonstrations end to facilitate transfer.

There are numerous possible reasons as to why animation is beneficial when it comes to transfer. One proposed reason is based on Cognitive Load Theory. This theory, first articulated by John Sweller, theorizes that learning occurs when information contained in instructional material is processed by modularized working memory and then moved to long-term memory, where it is stored in schematic knowledge structures ("Cognitive Load Theory (John Sweller)"). Based on the assumption that there exists a modular working memory processor devoted to an individual’s own movement, researchers believe that cognitive load theory can be used to explain why animated analogical demonstrations are more effective in facilitating transfer. In 2009, Wong et al. found that that animated instructions are more beneficial toward transfer that relates to paper-folding tasks than equivalent static graphics. Wong et al. believe that this occurred because the working memory processor may be facilitated by our mirror-neuron system thus
causing animated instructional sources to be more beneficial to transfer than static graphics for cognitively based tasks that involve human movement. Interestingly, Cognitive Load Theory also explains why some animated demonstrations do not yield high transfer rates. In a 1991 study, subjects were instructed how to use HyperCard™ in order to author tasks on Macintosh™ (Palmiter, Elkerton, & Baggett). These instructions were relayed to participants either via animated demonstration or text that the procedures needed to read. After the instruction period, subjects were asked to return for two further sessions. In these two sessions, users were asked to perform tasks identical or similar to the tasks used in the training session. However, during these sessions, researchers found that participants appeared to be mimicking the training demonstrations that were presented to them via animation and not processing the information. Interestingly, when participants were asked to infer procedures for tasks which were similar to those seen in the training session’s animated demonstration (testing the group’s transfer rate), the group of participants in the control condition who were given information via text was much better at deducing the necessary procedures than the animated demonstration group. This indicates that animated demonstrations were not able to facilitate transfer in this experiment. The researchers believe that participants were unable to transfer the knowledge that they garnered in their training session to the second and third session because they were unable to pause the video or rewind it, thus possibly overloading their working memory processor and inhibiting this new knowledge from being moved into long term memory (Palmiter et al., 2009). Based on these studies’ findings, it appears that animation is superior to other formats when it comes to facilitating transfer only if the source is presented in a way that does not overload an individual’s particular working memory processor.
Another possible reason as to why animation may facilitate transfer is that animation gives people a sense of relevant variables that they later employ for mental simulations. This theory is based on experiments such as The Viscosity Experiment that have shown that realistic animations teach about variables that facilitate future mental simulation strategies. In the viscosity experiment, participants were shown an animated demonstration of a moderately viscous fluid poured over two torus-shaped obstructions as well as a cylindrical container filled with the same fluid tilting at a constant angular rate. After the demonstration videos, participants were shown two new fluids, one with low viscosity and one with high viscosity. Participants were then asked “which container will need to be tilted with a larger angle before the fluid inside begins to pour out” based on the quantity of the fluid in each container and the angle of the tilt (Kubricht et al., 2016). Based on their results, Kubricht et al. concluded that participants appear to reliably employ mental simulation strategies when performing the viscous fluid-pouring task. This conclusion provides us with valuable insight regarding animation and transfer. The variables that the highly realistic animation in this experiment produced appear to be what enabled individuals to employ the mental simulation strategies necessary to solve the tasks they were presented. Without these variables, it is possible that subjects would not have been able to successfully manipulate the information that they received and solve the questions.

Analogies have been proven useful when it comes to solving difficult problems. However, the form of the analogy seems to make a difference in the solving rate. Research has shown that animated demonstrations enable individuals to solve difficult problems at higher rates than orally or text based demonstrations do, thus causing researchers to support the claim that animation facilitates transfer. Cognitive Load Theory and the Viscosity Experiment shed light onto why this source format is superior. Two possible future courses of study could be
uncovering under which circumstances animation is not the most beneficial to transfer and subsequently understanding why that may be the case.

References


Different laws have different motives and different moral underpinnings. One would expect that if a criminal act is a more severe moral violation, then the punishment should be harsher. Although law and morality can have strong influences on each other, they are not one and the same. Researchers, such as Andenaes (1970), Darley and Pittman (2003) and Rossi, Berk, and Campbell (1997), have examined the moral explanations of crime and punishment as well as the correlation between the seriousness of the offense and punishment prescribed by law and by average participants. Our present study used participants’ judgment of pairs of moral violations to rank the violations in seriousness. This ranking was then compared to sentencing guidelines in California. While the severity of moral violations generally corresponded with sentencing guidelines, there were still some key differences.

A common explanation for criminal sentencing and fining is deterrence. If an individual knows they will be punished for the crime, then they will be deterred from committing crimes. Furthermore, it is much harder for offenders to commit crimes once they are imprisoned. Andenaes (1970) examined the morality behind deterrence. He argues that punishment is needed to make the law effective. Without punishment, laws would not carry value. This is why legislators issue general punishments that apply towards everyone but still leaves space for individual decisions. Factors that determine the punishment include the offender’s culpability and the magnitude of the offense. Yet the flexibility can lead to unfair punishments to some offenders. Despite the law’s prescription for punishment, judges usually have a lot of discretion when determining a sentence for a particular offender. When a judge is deciding on a sentence, he or she must consider what is appropriate for this particular offender as well as what is
appropriate for the type of offense. Although the deterrent effect of punishment holds up morally, there is no scientific proof that deterrence works, which may make punishment immoral. Andenaes calls for societies to conduct more research on whether punishment actually prevents crime in order to gain scientific facts to base decisions on.

Another aspect of crime punishment is retribution, or “just deserts.” Darley and Pittman (2003) investigate the psychology behind this retributionist perspective where punishments do not try to deter or rehabilitate the offender but rather just punish him or her for crimes committed. They argue that the seriousness of a crime, which gauges the moral weight, highly correlates with a sentence. This correlation supports the just deserts perspective because the punishment is linked to the crime itself rather than the probability of the crime occurring again. Darley and Pittman (2003) conducted experiments to link the seriousness of the crime and the inflicted punishment. Using vignettes about crimes, they had participants assign appropriate sentences. The results suggested that people have just deserts motives when assigning punishments. In another experiment, Darley and Pittman found that participants’ degree of moral outrage correlated with the severity of punishment assigned.

While retribution may be an integral part of criminal sentencing, there is still variation in the punishment assigned for offenses. Rossi, Simpson, and Miller (1985) also used vignettes to examine the effects of the seriousness of the crime, social characteristics of offender, the harm inflicted on victims, the relationship between the victim and the offender, and possible moderating context. While they found that crime seriousness is the strongest indicator of sentence assigned, other factors played a role. Respondents rated female offenders less severely than male offenders whereas crimes against females were rated more severely. However, the offender’s social characteristics did not have much of an influence, other than previous criminal
history, and neither did the victim’s social characteristics. Respondents rated crimes against a person as less severe as opposed to property or victimless crimes. Offenses against strangers were rated more severe than offenses against those closer to the offender. Rossi, Simpson, and Miller findings suggest that punishment is not only based on the seriousness of the offense.

In order to conform sentencing practices in the U.S., congress created an independent agency in 1984 in charge of establishing federal guidelines for sentencing. The guidelines assign a numerical offense level based on the seriousness of the crime as well as a numerical level of seriousness of the offender’s criminal record. These values create a recommended range of sentencing that the judge can choose from for each individual case. Rossi, Berk, and Campbell (1997) examined how well these sentences correlated with public’s median sentencing. Although these punishments were designed to deter offenders from committing crimes while also serving as restitution and rehabilitation, the guidelines were not based on research on how well punishments actually work. They created vignettes for 20 different crime types, asked participants to assign sentences for each case, and asked agency staffers to plot offenses in federal guidelines. Participants’ sentence assignments aligned well with federal guidelines except for drug offenders.

In the present study, participants were asked to choose between moral violations. Participants had to choose the more severe violation between a pair of violations. The proportion of times a moral violation was deemed more severe created a measure of severity. Moral violations closer to one were determined more severe by participants whereas ones closer to zero were determined less severe. Several of these moral violations are also punishable crimes. Previous studies have demonstrated that participants assign higher sentences to more serious
offenses. Figure 1 compares the moral violations organized by severity, their severity proportion, and sentencing in California, if applicable.

<table>
<thead>
<tr>
<th>Moral Violation</th>
<th>Proportion</th>
<th>Sentencing in California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder</td>
<td>0.944</td>
<td>Murder: death, imprisonment in the state prison for life without the possibility of parole, or imprisonment in the state prison for a term of 25 years to life¹</td>
</tr>
<tr>
<td>Rape</td>
<td>0.912</td>
<td>Rape: 3, 6 or 8 years $70 to be paid to victim or $1000 to battered women's shelter²</td>
</tr>
<tr>
<td>Date-rape</td>
<td>0.801</td>
<td>Rape: 3, 6 or 8 years $70 to be paid to victim or $1000 to battered women's shelter²</td>
</tr>
<tr>
<td>Pedophilia</td>
<td>0.781</td>
<td>Lewd Acts with a Minor (under 14): 3, 6, or 8 years¹</td>
</tr>
<tr>
<td>Torture</td>
<td>0.772</td>
<td>-</td>
</tr>
<tr>
<td>Kidnapping</td>
<td>0.661</td>
<td>Kidnapping: 3, 5, or 8 years¹</td>
</tr>
<tr>
<td>Drunk-driving</td>
<td>0.599</td>
<td>DUI: 4 days to 6 months, Up to $1,000²</td>
</tr>
<tr>
<td>Assault</td>
<td>0.594</td>
<td>Simple assault: up to 6 months, a fine up to $2000²</td>
</tr>
<tr>
<td>Incest</td>
<td>0.582</td>
<td>Incest: 16 months, 2 years or 3 years and/or $10,000³</td>
</tr>
<tr>
<td>Arson</td>
<td>0.532</td>
<td>Arson: 3, 5, or 8 years¹</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.450</td>
<td>Robbery: 2, 3, or 5 years¹</td>
</tr>
<tr>
<td>Adultery</td>
<td>0.415</td>
<td>-</td>
</tr>
<tr>
<td>Bullying</td>
<td>0.398</td>
<td>Hate crime: maximum of 1 year in jail or a maximum $5,000 fine or both, and the court shall order the defendant to perform a minimum of community service, not to exceed 400 hours¹</td>
</tr>
<tr>
<td>Car Theft</td>
<td>0.377</td>
<td>Grand Theft Auto: no more than 1 year or $5000 fine or both²</td>
</tr>
<tr>
<td>Embezzlement</td>
<td>0.354</td>
<td>Embezzlement petty (&lt;$950): 6 months or less and fine up to $1000 grand (&gt; $950): up to 1 year²</td>
</tr>
<tr>
<td>Vandalism</td>
<td>0.213</td>
<td>Vandalism $400+: maximum of 1 year in jail or $10,000 fine by or if the amount of defacement, damage, or destruction is ten thousand dollars ($10,000) or more, by a fine of not more than fifty thousand dollars ($50,000), or by both that fine and imprisonment &lt;$400: maximum of 1 year in jail or a maximum of $1,000 fine or both²</td>
</tr>
<tr>
<td>Shoplifting</td>
<td>0.196</td>
<td>Shoplifting &lt;$950: maximum of 1 year in jail²</td>
</tr>
<tr>
<td>Slander</td>
<td>0.193</td>
<td>-</td>
</tr>
<tr>
<td>Trespassing</td>
<td>0.123</td>
<td>Trespassing: Maximum of 6 months in jail or a maximum fine of $1,0000 or both³</td>
</tr>
<tr>
<td>Lying</td>
<td>0.102</td>
<td>-</td>
</tr>
</tbody>
</table>

¹. California Penal Code
Looking at the range of punishments, one can see the range is longer for more severe crimes and the maximum is much lower for less severe crimes. Although participants’ ratings clearly rank the moral violations, the same sentences apply to several different violations. Findings from several prior studies suggest that the public assigns longer sentences to more serious crimes. Lawmakers are supposed to reflect the interests of its public. California sentencing guidelines gives judges a lot of flexibility when determining the appropriate punishment due to fairly large range of punishment. Therefore, looking at sentencing guidelines does not provide enough information to determine if punishment for criminal offenses reflects the severity of moral violations.

Perhaps a better measure of correlation between seriousness of offense and punishment would be the average sentence or fine for each moral violation in California and nationally. While these averages require much more research, they will provide a much better picture if the justice system in California and the United States is giving offenders punishments proportional to the crime committed, which is what the public wants. Beck and Blumstein (2012) did compare the estimated time served for several offenses nationally, shown in Figure 2, examined in our study. The length of sentences almost perfectly corresponds to participants’ rankings of moral violations. Although more research must be conducted, Beck and Blumstein findings suggest that justice system does take into account the severity of moral violation.
Figure 2: Taken from Beck and Blumstein (2012), which compares average sentencing nationally from 1980-2010.

Yet Beck and Blumstein also found a significant increase of time served beginning in the 1980s. An Economist article published in 2015, shortly after President Obama became the first sitting president to visit a federal prison, discusses the rapid increase in incarceration and argues that the change is due to unnecessary harsher punishments. There are large increases in several crimes, including approximately an additional 5 years for murder, 3 years for sexual assault, and 18 months for robbery. The author argues the longer sentences are not making the public any safer, as criminals in lenient societies are still imprisoned and many serving long sentences were not that dangerous in the first place. In a study done in California following reform due prison-overcrowding that reduced the number of imprisoned convicts, researchers found very slight changes on property crime and no change on violent crime. The article concludes that sentencing is no longer proportion to the seriousness of the crime, which can be considered a moral violation.

The United States has the highest incarceration rates in the world, as noted in the Washington Post in July 2015, which has led many to call for sentencing reform. While research
has been conducted on incarceration and the severity of the crime, there must be more because people’s lives depend on it. The effects of deterrence and punishment must be more clearly understood. Furthermore, we must examine if punishments are not just reserving retributive purposes but also rehabilitating criminals, so they will not become repeat offenders. Researchers must find if there is a correlation between the seriousness of the crime and the punishment prescribed. Looking back at Figure 1, there are quite a few sentencing guidelines that do match the moral severity. Assault has a much less severe punishment than arson and robbery. Participants ranked a moral violation against a person as more severe than crimes against property. Hurting an actual person may seem more wrong than damaging or stealing property, but assault may not as be as violent as people think. Participants may have categorized assault and battery together, but California separates the two with battery inflicting more harm on the victim. Although participants rate drunk driving as quite severe, the punishment is much lower than expected. Participants may be the thinking about the harmful consequences, as drunk drivers can kill innocent people. On the other hand, legislators could be focusing on the offenders’ intentions, as most drunk drivers do not intend to hurt anyone. However, legislators should be taking the horrible repercussions into account. Punishments are not always driven by moral judgments, which could mean the public has incomplete information or an impetus to change the punishment.

Whether or not there is link between crime seriousness and punishment is still question. If there is not, lawmakers must reform criminal justice so that sentences reflect the seriousness of the crime. Giving judges flexibility in determining punishment on a case-by-case basis is essential. However, lawmakers must consider providing more guidelines to ensure that offender
get the appropriate punishment for their offenses. Our justice system should be based on clear evidence that not only is punishment working but also fair.

References


Adaptive Learning

Nicole Mashian

This quarter we focused on the process of adaptive learning, a crucial topic in regards to learning and memory that can help improve various aspects of education in the real world.

In this field of research, one of the most well known findings is that of the spacing effect, which suggests that spacing out memory retrievals across time, or repeatedly being exposed to an item following delays, can help enhance memory when compared to non-spaced practice. In other words, distributing learning material across time improves long-term retention relative to short-term cramming (Dempster, 1989; Ebbinghaus, 1913; Glenberg, 1976; Rumelhart, 1967). In particular, longer delays have been shown to be more beneficial than shorter delays, but only up to a certain point (Benjamin & Tullis, 2010; Cepeda et al., 2008; Glenberg, 1976)—this maximum, after which the benefit decreases and “snaps,” occurs when items are presented again just before they are forgotten. Furthermore, the value of a presentation of an item is positively correlated with the difficulty of successful retrieval, otherwise known as the retrieval effort hypothesis (Benjamin, Bjork, & Schwartz, 1998; Pyc & Rawson, 2009). Combining these ideas, expanding spacing during the learning process can potentially produce difficult but successful retrievals, and consequently generate better learning.
Nonetheless, spacing by itself is not a determining variable in the optimization of learning; its interaction with the learner’s variable learning strength, however, could potentially enhance the learning process. The benefit of expanded retrieval intervals assumes a notion of learning strength that increases with repeated exposure to an item; learning strength is low when the item is first introduced, but increases after multiple trials. However, even if learning strength increases across time, predetermined intervals risk expanding too much or too little depending on the individual; too much variability exists, whether due to variable learning strengths or varying difficulty levels of certain items, to rely on preset spacing intervals. Even though fixed spacing is thus not ideal, adaptive spacing, which adjusts to each individual’s unique learning strength, could potentially be more effective.

Since response time has been shown to be a valid indicator of retrieval difficulty, and subsequently of current learning strength (Karpicke & Bauernschmidt, 2011; Pyc & Rawson, 2009), both accuracy and response time can be utilized to adaptively schedule spacing intervals. This method, which regulates spacing based on each learner’s accuracy and speed (the Adaptive Response-Time-based Sequencing or ARTS system), has generated extremely efficient learning in regards to factual items (Mettler, Massey, and Kellman 2011). Adaptive learning is thus a method by which an individual learns through dynamic schedules that change spacing depending on their ongoing performance—their reaction time and accuracy—rather than at a fixed interval. As the individual’s learning strength increases, items are automatically delayed and expanded.

In a geography experiment that examined the ARTS algorithm in using response time and accuracy to generate spacing, the principal investigators sought to discover not only which spacing intervals are most useful—adaptive or fixed—but also how these benefits are attained—
through adaptation to individual learners or adaptation relating to specific learning items. Adaptive scheduling was thus compared to fixed schedules in one experiment, as well as two fixed “yoked” schedules that were copied from adaptive participants in another (Mettler, Massey, & Kellman 2016). In both experiments, adaptive scheduling outperformed fixed conditions at immediate and delayed tests of retention, which suggests that there’s less forgetting of the information in the adaptive condition.

However, since a numerous amount of individual differences exist such as rate of learning or capacity of long-term retention, various questions arise regarding the utilization of reaction time and learning criterion. We consequently decided to explore some of these individual differences to see if we could discover significant implications in the data. We first looked at the relationship between reaction times for delayed posttests and training, and found a linear relationship such that those who were fast in training remained fast in delayed posttest and those who were slower responders remained slow. We then looked at this relationship across the two conditions, adaptive scheduling versus random scheduling, as illustrated in Figure 1. We not only found that reaction times are lower overall in the adaptive condition when compared to the random condition, but the slope in the former is also flatter, indicating that regardless of the reaction times in training, the reaction times in the delayed posttest tended to stay fast. In other words, individuals seemed to have learned better in the adaptive condition, causing them to reach a quicker level of fluency by the delayed test regardless of what their level of fluency was during training. We also analyzed the relationship between the number of trials it took for an individual to reach the learning criterion and their delayed posttest accuracy. As depicted in Figure 2, we found that those who required fewer trials to reach the learning criterion also tended to be more accurate in the delayed posttest. We then observed the relationship between reaction times in
training trials and delayed posttest accuracy, and found that while in the adaptive condition, faster response times were an indicator for higher accuracy, this was not so in the random condition as illustrated in Figure 3. Lastly, we conducted a forgetting analysis between the adaptive and random condition and found that those in the adaptive condition forgot less in the delayed posttest than their counterparts in the random condition.

Despite these observations that only begin to scratch at the surface, we still have further questions regarding the issue of individual differences, especially in regards to reaction time and learning strength. Since there’s a dualistic nature in regards to learning strength, such that fluctuations of learning strength can depend on an learner’s own variability and/or the variability of the individual items at hand, it is necessary to determine which of the aforementioned factors are more prominent when creating an adaptive schedule of spacing. It is also significant to analyze individual differences in order to see the variability in decay rates and durability, and try to see why it is that some learners are able to retain more for an extended period of time. By closely analyzing such differences in variability, we can better perfect the adaptive scheduling that has already been shown to lead to better learning.

It is therefore crucial to acknowledge the relevance of adaptive learning and its advantageous nature. Knowing that adaptive spacing produces greater learning relative to fixed schedules has direct applications for enhancing learning in many real-world domains. Spacing material appropriately has the potential to initiate considerable improvements in learning for students in educational settings, especially considering most curriculums employ learning schedules that lead to poor outcomes in terms of long-term retention (Rohrer & Taylor, 2006; Snider, 2004). For the most part, current educational tactics fail to distinguish between
immediate performance and long-term retention (Bjork & Bjork, 2011), and result in the student not reaching their full potential. Rather than spacing out their studying over time, students typically choose to cram relatively last minute, remembering the information for the short term, but letting the material slip away in the long term. Adaptive scheduling, which tracks and implements uniquely spaced learning schedules to yield the most gains, can thus prove useful to both students and instructors, and provide each individual an optimal manner by which to learn, and most importantly retain, the information at hand.
References


Schedules of Practice.


*Figure 1.* Each data point is an individual user.
Figure 2.

Figure 3.
Action Synchrony

Noelle Hannum

Without the ability to cooperate and communicate effectively, every human would be figuratively stranded on an individual island, only able to succeed, achieve, and grow according to his or her own specific set of innate skills. Social interaction is the driving mechanism behind many of the world’s greatest inventions and breakthroughs, and the backbone of many a person’s personal fulfillment. But what drives such interaction? How do people perceive, interpret, and respond to social intricacies in such a way that is considered “correct” according to social norms and successfully achieves goal-directed behavior? What factors inhibit social perception? This paper aims to explore these issues.

A 2011 experiment by Christensen, Ilg, and Giese studied concurrent motor execution’s facilitation of the perception of human motion in point-light displays. In general, performance of some motor action affects how an individual observes actions and perceives biological motion. The link between perception and action has theoretical roots in the study of mirror neurons, as well as studies into the effects of “perceptual resonance” which can facilitate or inhibit sensations of motion. Another related theory postulates that action observation uses dynamic motor associations to internally model an observed behavior, which in turn allow the generation of further sensory predictions. This study then postulated through these theories that the level of spatial and temporal congruency between executed and observed actions should directly affect the facilitation or inhibition of action recognition. Christensen, Ilg, and Giese studied the manipulation of these levels on perception of a point-light display of a waving human arm presented in a noise mask on a computer screen across the room from the participant executing the actions. They varied the temporal coherence by incrementing the stimulus onset time and the
spatial coherence by varying the rotation of the stimulus. They hypothesized that a high congruence between motor execution and observed motion would facilitate perception while incongruence would contradict sensory input and thus delay or completely remove recognition. They found a significant effect of time delay such that larger delays between the execution of motion and its observation interfered proportionally more. The same effect was found for spatial coherence and incoherence, such that a greater rotation angle proportionally decreased perception. They controlled for the use of “cheat” strategies by reflecting arm motion across the vertical axis, and found that this inhibited perception, meaning participants were not using simply distances between points of light to determine detection, and that the link between visual and motor representations of actions is highly specialized and selective. This study also controlled for an effect of self-recognition, such that participants awareness that the point-light display reflected their own movements was shown not to affect perceptual accuracy. From these results, Christensen, Ilg, and Giese were able to demonstrate that “biological motion detection is facilitated by concurrent motor execution only if the observed and the executed action were in approximate temporal synchrony and spatially congruent” (Christensen, Ilg, and Giese, 2011). This lends support to the theories that vision and motor control share a dynamic representation, or that those two individual representations are at least closely linked. It also supports the theory that sensory prediction arises out of this process, or is at least highly involved.

A second study conducted by Loula, Prasad, Harber, and Shiffrar (2005) explored the effect of motor and visual experience on sensitivity to human action. Their research into the study of biological motion arose out of the studies done confirming that point-light data by itself can determine “emotional state, deceptive intent, motor effort, vulnerability, and gender” and even sexual orientation (Loula, et al., 2005). This seemingly abnormal sensitivity to specifically
human motion could be due to the fact that it is the only type of motion produced as well as perceived, humanity’s lifetime experience of watching people move, and/or the existence of mirror neurons. Nevertheless, “superior prediction of one’s own actions supports the hypothesis that participants use their own motor experience to perceive human action” (Loula, et al., 2005).

The goal of this study was to determine what conditions contribute to analysis of human movement through motor system input and perceptual learning. They had participants and their friends record common actions to be turned into point-light displays, and invited them back after a couple months to identify the actions of themselves, friends, and strangers. They found that self-recognition was highest, followed by recognition of a friend’s actions, with stranger recognition the least accurately identified. This result was replicated in a similar second experiment where participants were asked to discriminate between different actors’ point-light actions- the actors were correctly judged to be the same most often when the actors were themselves, then friends, then strangers. These findings support the theory that visual experience, and most importantly motor experience, aid in perception. Another intriguing result of this study was the finding that more specialized, expressive actions like dancing and playing ping pong were identified as belonging to individuals most accurately, while the perception of generic actions like walking and running approached chance discrimination, despite the fact that more general actions like walking or running were detected in themselves most accurately more. This is most likely not due to human’s lack of sensitivity in perceiving such actions and more likely due to the lack of personal identity associated with these actions, but more research into this specific finding is needed to explore why. However, these findings combined provide even more support for the motion-perception representation linkage theory discussed in the Christensen, Ilg, and Giese study.
A third related study by Nackaerts, Wagemans, Helsen, Swinnen, Wenderoth, & Alaerts (2012) explored the perception of biological motion and emotion of point-light displays in people with varying degrees of autism spectrum disorder. The term autism spectrum disorder (ASD) encompasses a group of diverse and “complex, polygenic neurodevelopmental disorders which are characterized by social and communication deficits, in addition to repetitive behavior and restricted interests” (Nackaerts, et al. 2012). There have been numerous studies that have explored ASD effects on facial recognition of emotion, but social interaction in the realm of body language is equally important. Studies have shown that ASD individuals display deficits compared to typically developed (TD) individuals in verbally reporting human emotions and subjective states, but not in verbally identifying basic actions or objects. One study of ASD and TD toddlers even showed that TD toddlers demonstrate a looking preference for biological point-light displays and biological motion, while ASD toddlers do not. Nackaerts, et al. decided to utilize two of the most recent point-light recognition tasks to explore biological motion recognition as well as emotion recognition in adults with ASD (some professionally diagnosed with autism as well as the less-severe Asperger’s syndrome). They all scored above a 60 on the Social Responsiveness scale, a range highly correlated with ASD. Nackaerts, et al.’s study tested these participants on “person” identification in a series of point-light displays, as well as forced-choice emotion recognition. Person identification involved determining as quickly and accurately as possible from either a biological motion or scrambled point-light display whether or not the series of dots was a person. Emotion recognition involved asking the participant whether a second point-light display was “happier, sadder, angrier, or not different, from the [neutral-emotion] prime” (Nackaerts et al., 2012). Both parts of the study included a second decision or choice, with the same stimuli, in a color identification task, in which one dot changed color and
participants had to quickly and accurately choose the correct color. This served as the detection control. Accuracy, reaction time, and eye movements were recorded for each stimulus and response. For both biological motion and emotion recognition, ASD participants were less accurate and slower to respond compared to TD participants, but accuracy and response times were comparable in the control conditions. ASD participants also showed significantly higher rates of eye movement compared to TD participants, indicating that they were focusing less time on individual aspects of the display. Furthermore, the same group of participants was used in both the biological motion and emotion recognition portions, allowing for comparison across categories. From this analysis, degree of biological motion recognition was shown to predict degree of emotional recognition, and rate of eye movement was shown to predict accuracy on emotion recognition, such that a lower rate of eye movement indicated greater ability to detect emotion. Altogether, these results give promising evidence supporting further investigation into these differences.

These studies, along with many others, are attempting to explore and explain similar issues- how do people perceive human action and interaction, and what factors affect this perception? The research I’m directly involved in is starting to explore these links. We have 28 participants so far, 3 male and 25 female. We have them first complete an autism quotient (AQ) questionnaire to obtain an understanding of where each participant falls in relation to having autistic- or asperger’s-related tendencies. Scores above 32 highly correlate with diagnosed ASD, and scores above 25 are considered borderline. Scores below 14 indicate little to no tendency towards exhibiting autistic traits, with scores between 14 and 25 representing the general population average. Participants then complete a task where they are asked to determine the degree of interaction of biological motion stimuli on a scale of 1 (no interaction) to 7 (completely
interacting). These stimuli consist of two point-light actors engaging in various joint or individual activities, for example, ballroom dancing and fighting. During the main portion of the experiment, varying degrees of temporal incongruency are introduced to study the effect of time delay on perceived interaction. We hypothesize that greater temporal difference will result in lower interaction scores, and are interested in the relation of AQ scores to perceived interaction. However, this experiment is still in the beginning stages, and further participants are currently needed. Sometime next quarter these preliminary results will be evaluated to determine future direction and/or modifications to the current experiment.

I’ve loved being able to be a part of this research so far, and I look forward to next quarter and the discoveries it will bring. I’m excited to analyze and see the results of what we have done so far and their implications. Social interaction is something I find very intriguing overall, and is something inherent in and important to every aspect of life.
References


Perceptual priming and hierarchical biological motion perception

Pratyusha Javangula

Biological motion is defined as the activity of an animate creature; biological motion perception is understood to be the general ability of humans to perceive an animate human given degraded visual input (e.g. a point light display) (Johansson, 1973; 1976). Biological motion perception is an essential component of cognition and visual perception specifically, as humans must be able to effectively organize dynamic visual inputs of other moving humans and animals into stable percepts in order to draw conclusions and make judgments about them. Previous research investigating motion perception (biological motion, transparent motion, and reference frame effects) concluded via a Bayesian model that motion perception is organized hierarchically (Gershman, Tenenbaum, & Jäkel, 2015). Nevertheless, there remains a lack of sufficient empirical evidence to support this hypothesis. As a research assistant for Dr. Hongjing Lu’s lab at UCLA, I facilitated data collection in an experiment investigating the hierarchical biological motion perception hypothesis via an experimental paradigm that leveraged neuronal oscillations in order to test encoding of middle-level motion components. The results of this study could possibly provide empirical data to support the hierarchical biological motion perception hypothesis, leading to a deeper understanding of how humans utilize their visual system to act on and interact with their world effectively.

The study contained three parts, the first of which is related to the investigation of hierarchical biological motion perception. The first of the 3 tasks was the perceptual priming task, in which participants were exposed to a prime stimulus colored in red (either a point light display or a walking stick figure). The prime stimulus was followed by a stimulus-onset
asynchrony (SOA) varying from 50 ms to 500 ms in steps of 16 ms. Following the SOA, participants were exposed to a probe stimulus colored in black (a point light display) for 300 ms. Participants were asked to judge the facing direction (left or right) of the probe stimulus. A spectrotemporal analysis was then performed on the response time, designated by the lag time between probe onset and key-press for correct trials only, as a function of frequency (0-25 Hz) and time (cue-to-target SOA).

In addition to previously published research, research done by the lab utilized a non-parametric Bayesian model in order to explain the inference of hierarchical motion structures that produce observed visual input. The lab’s hypothesis was that biological motion perception is hierarchical and nested, allowing individuals to perceive biological motion even when provided with only impoverished visual inputs. The models are based on the nested nature of the body as it is moving (i.e. a foot is connected to an ankle, calf, knee, and thigh, which make up a leg, which is a part of the body in general). The results of this generative model account for a lot of the phenomena currently present in the body of literature surrounding biological motion perception. However, these results suffer from specific limitations inherent in using a computational model; most pertinently, that simulations cannot carry the same weight as empirical data collected from human subjects.

A study conducted by Gershman, Tenenbaum, & Jäkel (2015) utilized a Bayesian computational model and psychophysical experimentation to demonstrate general hierarchical motion perception (including biological motion), consistent with our hypothesis. In this study, Gershman et al. (2015) utilized a probabilistic generative model of motion with two parts: a probability distribution over trees and a probability distribution over image sequences given a
particular tree-structured configuration of motion components. They proposed that Bayesian reasoning can invert the model and access the fundamental hierarchical structure of the moving images. They illustrate several examples in which Bayesian vector analysis can account for seminal experimental phenomena in the field of motion perception (Gershman et al., 2015).

In addition to the computational model, Gershman et al. (2015) conducted a psychophysical experiment. The researchers exposed four adult subjects to oscillating dot quintets varying in their foundational motion tree structure. Each quintet contained a red dot, a blue dot, and the rest were white; participants were asked to judge the movement of the red and blue dot relative to each other, if any. Participants were shown 32 trials of each quintet with eight different dot comparisons.

The researchers modeled their data using the same Bayesian vector analysis used for the simulation component of the study. Results showed that subjects did, in fact, extract the fundamental hierarchical structure of the moving stimuli in order to make decisions about them. Researchers were further able to conclude that the computational model accurately captured the pattern of response probabilities, $r = 0.98, p < 0.0001$. In addition, results showed that entropy was significantly correlated with response times, $r = 0.73, p < 0.0001$.

Collected psychophysical data and the results of the computational model and subsequent Bayesian vector analysis as simulation suggest that motion is actually perceived in a hierarchical fashion. Researchers address several limitations of their study, the most pertinent of which are the following: first, that it is insufficient to rely the generative model on the assumption that motion components are combined through summation, and second, that the simulations don’t specify the mechanisms by which Bayesian vector analysis is carried out. Lastly, they go on to
assert that future directions for hierarchical motion perception research could include discovering a neural implementation of the aforementioned phenomena (Gershman et al., 2015).

Furthermore, a study conducted by Dittrich (1993) whose results suggested that biological motion perception starts primarily on an intermediate level, aligning with our hypothesis that in a hierarchical model of biological motion perception, middle-level action components are encoded. The study was conducted with 38 participants (14 women and 24 men) who were presented with point light displays of 12 actions in three categories (locomotory, instrumental, and social) under three conditions: light points were positioned at the joints, light points positioned midway between the joints, and the first condition flipped upside down. Participants were shown each movement condition combination once, along with 12 control displays (nonbiologically moving light-spots) in random order for five seconds with 10-second intervals where the screen was dark. Participants pressed a button to indicate when a movement had occurred and verbally categorized the movement (e.g. “dancing,” “boxing,” “hammering”).

Results showed a statistically significant difference in accuracy of motion recognition for locomotory, instrumental, and social movements, $F(2, 37) = 84.50, p < 0.001$. There was also a significant difference in motion recognition accuracy between light-spot conditions, $F(2, 37) = 142.25, p < 0.001$. The data also revealed a significant main effect for movement type in motion-recognition time, $F(2, 37) = 38.90, p < 0.001$. There was also a statistically significant difference in motion-recognition time between light-spot conditions, $F(2, 37) = 75.51, p < 0.001$. Lastly, the data revealed a significant interaction between light-spot condition and movement type for accuracy of motion recognition, $F(4, 74) = 4.52, p < 0.05$, as well as for motion-recognition time, $F(4, 74) = 6.27, p < 0.001$. 
The data suggested that the type of movement and action category presented to participant strongly influences the efficiency and speed of action recognition. From these data, the experimenters concluded that action classification “is formed in the sense of a hierarchical order of dynamic movement codes or temporal phase relations,” in accordance with our lab’s hypothesis (Dittich, 1993). Dittich (1993) goes on to conclude that the data provide support for the idea that action coding involves not only structural motion components, but also a semantic coding, such that causal interpretations can be perceived immediately as opposed to in later stages of information processing.

Finally, Jokisch, Daum, Suchan, and Troje (2004) conducted research to ascertain if a hierarchical model of biological motion perception is accurate by modulating event-related potentials. The results of their research showed an early negativity with a peak at 180 ms that was more pronounced during perception of point-light displays of upright walkers compared to inverted walkers and scrambled motion displays, localized to areas associated with attention as it relates to perception. These results are in accordance with the theory that scene interpretation progresses along a feedforward hierarchy that leads to increasingly complex representations. 15 participants (8 females and 7 males) were shown 60 trials of point light displays each of 3 conditions: upright walkers, inverted walkers, and random motion. Participants were asked to judge if the movement was biological motion or not.

The data showed a significant difference in response time for upright walkers compared to inverted walkers and random motion, $F(2, 20) = 27.66, p < 0.001$. Furthermore, grand averages of the ERP data show the first negative component peaks on average at a latency of 183 ms (referred to as component N170). There was a statistically significant difference in peak
amplitude of N170 between upright walkers, inverted walkers, and scrambled motion where N170 was the most pronounced in the upright walker condition, $F(2, 28) = 9.97, p = 0.001$.

Researchers concluded that the pronounced N170 component observed during perception of the upright walkers is reflected in the pop-out phenomenon of perceptual experience of a moving body from impoverished point light display stimuli. Jokisch et al. (2004) go on to assert the necessity of a feedforward mechanism for this phenomenon to occur, given the short latency of the component. These results suggest a hierarchy of processing of an animate form and its movement.

The aforementioned research investigated the question of how biological motion is perceived, and all of the results go to support the hypothesis that information about biological motion is processed via a hierarchical structure. The study in the Lu Lab seeks to augment this growing body of literature by providing much-needed psychophysical data to ascertain the presence of a hierarchical structure in human subjects’ perceptual experiences beyond what is offered by computational models. The current study intends to investigate the presence of a hierarchical structure by leveraging neuronal oscillation patterns and the priming paradigm, facilitating the testing of middle-level component encoding. Furthermore, this study has potential in the future to provide new insight into the underlying deficits that lead to poor biological motion, like what has been previously observed in autistic individuals.

As a research assistant in the Lu Lab, I’ve had the opportunity to participate in the scientific research process at many different stages, from participant scheduling via the UCLA Sona Systems Undergraduate Subject Pool to facilitating data collection using a MATLAB program. As a facilitator, I am responsible for explaining the intent of the current study, as well
as instructing the participant through the reasoning task and resolving any issues that may arise.

Working in the Lu Lab this past quarter has been a wonderful learning experience for me, and has strengthened my resolve to further my studies in applied psychology as I pursue a Ph.D in cognitive science after graduation. I look forward to working in the lab this upcoming quarter as the experiment progresses and more data is collected.
References


Reducing Cognitive Load in Multimedia Learning

Roy Arguello

This review examines how to maximize learning from multimedia presentations by re-thinking how they are designed and implemented. Multimedia consists of pictures, words, speech, and/or animations in an educational or informational context that are used to facilitate learning. Photos, PowerPoint presentations, diagrams, podcasts, and videos are all examples of multimedia that are used in learning (Mayer & Moreno, 2003). There is usually a combination of multimedia resources that is used simultaneously in an attempt to convey information in an optimal fashion, but the best combination is not readily apparent. When considering the optimal combination of multimedia resources, it is necessary to consider the effects of cognitive load. Cognitive load refers to the burden of cognitive processing on an individual while they are learning and recognizes that an individual’s cognitive resources are limited. Chandler and Sweller (1991) assert that cognitive load occurs when students are required to participate in mental activities, like integrating disparate information and mindless repetition of practice problems without feedback, that do not contribute to a true understanding the material. These activities require mental effort and are not helpful for learning, so they should be excluded from presentations and other learning activities that instructors provide. Based on previous research in multimedia learning, the combination of audio and visual information together is best for reducing cognitive load in a presentation because it minimizes the burden that is put on either channel- in this context, channel simply refers to a pathway through which information travels. While using more than one channel to convey information may seem like a counterintuitive
approach to reducing cognitive load, dividing the information flow between auditory and visual channels is an effective method of facilitating learning.

**Theories of Cognitive Load Reduction**

The coherence principle refers to the idea that minimizing the amount of irrelevant material in a given presentation is effective for reducing cognitive load (Mayer & Moreno, 2002). When greater amounts of information are conveyed in a multimedia presentation, the student’s cognitive resources are under greater stress from the additional informational load. Intuitively, the coherence principle makes sense because minimizing words, pictures, and/or sounds frees up cognitive resources by reducing the total amount of information processing required for a given multimedia presentation. If the student has to process and discard irrelevant information in order to extract the meaningful content, then the limits of their attention are being pushed unnecessarily. There is incidental processing that occurs when irrelevant information is present, which results in a reduction in cognitive capacity that hinders the ability to process essential information (Mayer & Moreno, 2003).

Additional information presented through the visual channel has been proven to hinder recall and recognition of information. A study by Bartsch & Cobern (2003) demonstrated that students who were given lectures with PowerPoint presentations with additional images and graphs performed worse on a quiz of that information than students who received lectures with PowerPoint slides containing only text. Additionally, students who were given PowerPoint presentations with facts and irrelevant pictures recalled the facts worse than students who had slides with only text or a related picture coupled with the fact- it is also worth noting that the students ranked how much they liked each of the types of slides, and the slides with irrelevant
pictures were given the highest ranking. While instructors may include irrelevant pictures on
lecture slides with the intention of providing comic relief to their students or piquing their
interest with humor, the irrelevant pictures are distracting and can take away from learning. The
incidental processing of the irrelevant images takes away from students’ ability to focus on the
most pertinent information and engage with the material in the most meaningful way possible
(Mayer & Moreno, 2003). Instructors should aim to minimize the amount of “noise” in their
lecture presentations so that students will be able to focus on what is essential. Similarly,
extraneous sounds during a learning period should also be avoided, as Moreno & Mayer (2000)
demonstrated that groups who heard background sounds and music during a presentation
performed worse on transfer and retention tests of that information than individuals who did not
hear any noises during the presentation. Consistent with the coherence principle, stimuli that
were not directly relevant to the presentation negatively affected performance on a learning task,
which further demonstrates the importance of preparing multimedia presentations in such a way
that excludes irrelevant sounds, images, or text.

Similar to the coherence principle, the redundancy effect refers to the notion that students
are better able to understand a multimedia presentation when words are presented to them
auditorily as opposed to shown in on-screen text and auditorily. This is due to the fact that visual
working memory becomes overloaded with the text on-screen, especially if there are other
pertinent images or diagrams (Mayer & Moreno, 2003). Teachers will often display redundant
images and text along with an auditory narration of the material because students can tune into
whichever part or parts are most useful to them (Mayer & Moreno, 2002). Some students may
prefer auditory information and others may prefer visual information, so teachers will attempt to
convey information in all of these ways to try to reach as many students as possible. By taking
this approach, the teacher assumes that they will be able to present information through each medium (audio, visual, text, etc.) in an equivalent way, which is rarely the case. Additionally, students cannot count on teachers to have the same style- some will auditorily repeat the information that appears on-screen and others will present auditory information that is asynchronous with the on-screen information. The process of integrating auditory and visual information does not facilitate learning, and the additional cognitive load from the integration process hinders the process of learning (Kalyuga, Chandler, & Sweller, 1999).

An experiment by Kalyuga, S., Chandler, P., & Sweller, J. (2004) demonstrated evidence of the redundancy effect and showed that displaying auditory and visual information concurrently is not conducive to an increase in learning by performing three experiments on a group of technical apprentices. In the first two experiments, they gave the participants two different types of presentations- one where there was auditory information that was presented alongside a visual summary of that information and one where there was auditory information presented in isolation that was followed by a visual summary. The participants who received the concurrent auditory and visual presentations performed worse on subsequent tests, received lower efficiency ratings, and rated the mental load of the presentation higher than the group who received auditory information and then a visual summary. To further their claim that cognitive load from redundancy hinders learning, they tested a presentation with the same concurrent auditory/visual information against a presentation that was audio-only. The participants in the audio-only condition outperformed participants in the concurrent auditory/visual condition in both test scores and efficiency. From these experiments, it is evident that redundant multimedia presentations can be harmful to learning and should be avoided because they unduly consume cognitive processing resources. Repetitive information should be avoided or presented after the
instructor is done speaking so that students will be able to fully focus on both the instructor and
the visual media.

While the coherence principle and redundancy effect focus primarily on how to reduce
the contents of multimedia presentations, the modality effect postulates that multimedia
information is best conveyed in an audiovisual format where auditory and visual information
together are more effective than solely visual information (Brünken, Plass, & Leutner, 2004) due
assumptions of the multimedia dual-processing theory (Mayer & Moreno, 1998), which supposes
that the processing systems of visual and auditory information are separate. Cognitive load can
be reduced by off-loading (Mayer & Moreno, 2003) information from one channel to another.
For example, a student can see a presentation with on-screen text and animations, but their visual
processing system will become overloaded quickly because they must simultaneously attend to
the text and animations. To alleviate their cognitive load, the on-screen text could be off-loaded
to the visual processing system so that the student would be able to listen to the text and pay
attention to the visual information in the animation. On the surface, the modality effect seems to
contradict with the redundancy effect, since there is evidence that concurrent presentation of
auditory and visual media hinders learning (Kalyuga et al., 2004). However, there is a subtle
difference: audiovisual presentation of information is beneficial when the auditory information
serves to reduce the amount of visual information that one must process. Presenting different
pieces of information through the audio channel and different pieces information through the
visual channel is beneficial for learning, whereas conveying the same information through both
channels is harmful. Brünken et al. (2004) conducted an experiment where they presented a
program about the human physiological system, where half of the participants viewed the
program with diagrams and narration and half of the participants viewed the program with
diagrams and on-screen text instead of narration. The group that received the diagrams and narration scored significantly higher than the other group, which gives evidence that audiovisual presentation can alleviate the effects of cognitive load. To improve the effectiveness of their presentations, instructors should avoid using text when it can be verbalized, especially if that text is in the presence of other visual media that need to be processed. The instructors should do their best to balance the amount of information that is conveyed through each channel in order to minimize the burden on the student’s total processing capacity.

A study by Wecker (2012) demonstrates the importance of strategically crafting the information on slides. Lectures presentations were given with either no slides, regular slides containing some terms and definitions, and concise slides that had only terms. The overall retention of information was best when participants were presented with concise slides, but participants’ retention with regular slides was actually worse than retention with no slides. From this study, it is clear that lecture slides should contain less information than they typically do because large quantities of information (especially repetitive information) can hinder learning instead of helping. Similarly, a study by Leahy, Chandler, & Sweller (2003) found that test performance was better when participants were given diagrams with text as opposed to diagrams with text and a narration, which implies that redundancy of material on slides also contributes to worse test performance. While it may not seem intuitive, exclusion of information from slides presented in lectures helps students learn more than including more information.

Cognitive load should be minimized when it takes away from the student’s learning experience, but it is necessary to consider that introducing some degree of difficulty can be beneficial to learning. Bjork & Bjork (2011) demonstrate evidence of success of desirable
difficulties in learning, such that students who receive presentations that vary in form will outperform students who receive information from a single method of presentation. Additionally, Bjork and Bjork (2011) propose that instructors should ask students to generate previously taught material on their own during presentations instead of repeating previous information, so that students will improve their memory retrieval instead of re-encoding the material in an attempt to make it more memorable. The idea is that students will learn more from retrieving information than from having it repeated to them, so instructors should demand more from their students by engaging them through testing events throughout their presentations. These findings seem to be at odds with the research on cognitive load reduction in multimedia learning since they recommend increasing the demand on students, but desirable difficulties and cognitive load reduction are not mutually inclusive. Minimizing cognitive load involves being mindful of not repeating information and dividing information across modalities so that it can be processed more easily, both of which aim to convey information in the most efficient way. Introducing desirable difficulties entails varying the modes of presentation and engaging the students more, which can be done without being repetitive or losing efficiency in information transfer.

**Practical Suggestions for Multimedia Presentations**

Taking into consideration all of the theories and empirical evidence, a quality multimedia presentation will need to be one that is efficient in the way that it conveys information. In congruence with the coherence theory, the presentation cannot contain irrelevant information that does not contribute to the main idea(s) that are being taught because processing that information decreases processing of essential information. Additionally, a quality presentation will not auditorily repeat information that appears in a visual form of the presentation in order to avoid
unnecessary processing. Finally, a quality presentation will convey information to both the auditory and visual channels equally whenever possible so that one channel will not become overloaded. While the human component of a presentation is irreplaceable, it could be the case that learning is better if auditory information is conveyed through a recording. A study by McKinney, Dyck, & Luber (2009) found that students who listened to a podcast of a lecture with PowerPoint slides performed better on a test of the material than students who attended a lecture in person with the same slides. The study does have potential confounds- students in the podcast condition were able to stop and rewind the podcast (they were not told this was possible) and took more notes than the students who attended the lecture. The differences in performance may be attributed to the ability to stop the audio and take more notes, but it is possible that attending to the speaker induces some cognitive load because students may look at the professor while they are speaking. Similarly, the classroom setting may provide other distractions that would not occur if a student listened to a podcast on their own, so instructors should not dismiss the benefits of podcasting lectures. There is evidence that presenting material in a personal form instead of a general form improves performance on transfer tests (Mayer, Fennell, Farmer, & Campbell, 2004), so it is possible that the ability to personally interact with the media could explain the success for students who had podcasted lectures. The ideal multimedia presentation will minimize cognitive load in both the auditory and visual channels, will be personalized for the individual student, will have a minimum amount of instructions, and will challenge students to engage with the material in meaningful ways. Learning can be drastically improved if instructors adopt teaching strategies that are mindful of the effects of cognitive load.
References


Classical views thought of perception as being too low level to affect abstract thinking and learning, however new research has demonstrated its abstract qualities. This view of perception embraces the idea that perceptions most fundamentally important aspects are in fact “sensationless” (Gibson, 1979). Whereas previous attempts to strategically teach skills focused mainly on fine-tuning declarative and procedural knowledge, the idea of perception being connected with higher-level processing led researchers to attempt to create perceptual learning modules (PLM’s) that affect these mechanisms. Perceptual learning leads to generativity, fluency, implicit pattern recognition, and durability, however creating modules that impact these characteristics is a difficult task. In this paper, I will discuss what properties are crucial for developing PLM’s, as well as some other possible properties that may lead to further enhancement of PL. I will use my own individual experience running through a particular PLM, one that taught me to read and interpret a soldier’s vital monitor, to facilitate this discussion. This module included an adaptive spacing algorithm, a cutting-edge idea in PLM’s, which hopes to improve perceptual learning by monitoring users progress when deciding which category to present next.

High-level perceptual learning interventions attempt, and previous research has supported, to positively influence two important concepts: discovery and fluency (Kellman & Massey, 2013). Discovery is a critical part of learning, and perceptual learning especially. Developing the ability to see what is important in a situation has been widely accepted as the essence of meaningful learning. Analogous to perceptual learning’s natural facilitation in the
real-world, PL modules should allow discovering and encoding relevant features and relations among categories/problems on their own, in addition to the ability to ignore irrelevant information. For example, a child does not receive lectures on what makes a dog a dog, however their perceptions allow their mind to recognize patterns and discover the features that distinguish them on its own. Fluency refers to the speed, ease, reduced cognitive load, and the eventual automaticity of processing abstract relations. Once a learner increases their fluency in a particular subject, it allows them to discover even more aspects of a particular concept. This synergistic relationship is believed to be the basis of the development of expertise. As I was running through the PLM that taught me to read and interpret soldier’s vital monitor, I was able to experience how PL leads to these concepts hands-on. As I discovered the relevant features behind what vitals are important to focus on for a particular category/problem, I was able to increase the speed by which I could answer the questions. This, in turn, allowed me to discover other relevant features, further increasing my fluency.

The ability of PLM’s to enable the strength of discovery and fluency relies on several crucial general properties (Kellman & Garrigan, 2009). First, they must facilitate the extraction of structure; a learner must be able to encode, discriminate, and classify structure. Second, there must be numerous classification trials with varied instances, allowing for relevant properties to be separated from irrelevant properties. This property is critical for transfer, one of PL’s most significant learning influences. Lastly, PLM’s should emphasize explicit instruction as little as possible. These properties enable a learner to select the relevant relational and abstract information whilst being constantly surrounded by a variety of stimulation. These properties were properly demonstrated in the vital monitor module I participated in. This PLM allowed me to classify particular vitals concepts and discriminate them from others. For example, when I was
presented with a particular arrhythmia and the vitals of the soldier with that arrhythmia, I was able to discriminate the vital structure of the irregular heart rate from a normal heart rate, or the heart rate of a different arrhythmia. Since after being presented one arrhythmia I was presented with a different type of exemplar, it allowed me to discover the structure behind what classifies that particular arrhythmia without having explicit instruction. I ran through this module twice, the second time I ran through it I noticed the effects the PL had on me. Rather than explicitly remembering how to identify the arrhythmias, I implicitly, and immediately, knew which information to focus on and which to ignore. I was surprised by how durable this learning was. The structural intuition and implicit pattern recognition I had, even after a week, was strong. This high-level PL intervention allowed me to focus specifically on the important relational structures.

The current research specifically explored whether adaptive spacing based on category sequencing can improve perceptual learning with regards to the understanding of vital arrhythmia’s and soldier injuries in the battlefield. “Spaced” practice has previously been shown to improve learning by implementation of an algorithm that presents a particular category according to an individual’s learning strength in that particular category (Mettler & Kellman, 2014). The algorithm decides which category has priority and should be presented next in a PLM by looking at the individual’s previous mastery of that particular category. In addition to an individual’s accuracy in a certain domain, another main factor that the algorithm focuses on is response time. How long it takes someone to answer a problem in a category is a useful indicator of the retrieval difficulty of that category. Items that are better mastered should take longer to be presented because items are best represented just before they are forgotten. On the other hand, categories that are poorly classified must be presented closer to each other to facilitate
understanding of structure and discovery of distinguishing features. While first running through the module, I was able to distinguish the features that allowed me to identify a specific problem category. For example, depending on what problem was presented, I was able to specify which vital was important to focus on. In time I was able to do this with efficiency and less cognitive load. Once I was more accurate and was answering the problems quicker, I was presented with a new category, for example I was asked to specify which treatment needed to be made when a soldier got a particular injury. Eventually, I was presented with another vital arrhythmia, just before I was able to forget the vital arrhythmia structure.

A previous experiment on adaptive response-time based category sequencing in PLM’s demonstrated the benefit of presenting perceptual learning with this algorithm, it also discovered that the benefit is greatest for categories with lower variability among instances. Therefore, a good way to make these modules even more effective would be to make the categories less broad, or to specify subordinate categories of problems, rather than more basic or superordinate categories. The actual implementation of how to classify these categories is something that would need further research to investigate.

Another possible direction to go to make these modules even more influential to learning could be to specify which exemplars in a particular category should be presented when. This would require further research to see which exemplar is the best to present. For example, should the most general problem in a category be presented first, or is it better to make this factor randomized. Although one of the most important aspects of these PLM’s is to facilitate the discovery of what features are important to focus on and which ones are irrelevant, initially presenting instances with less cognitive load, so it’s easier to classify which features are
important, and then presenting other, irrelevant, features, may make it easier for learners to initially extract the important structure. As is with the other possible directions to improve the module, further research must be done. Especially since this may inhibit one of the most important aspects of PL learning, discovery.

Previous studies have shown the impact of adaptive spacing techniques on factual and procedural learning, however its implementation on perceptual learning is something that has not been done until now. The present study hopes to demonstrate how adaptive scheduling strategies that enhance declarative learning domains, in this case the knowledge of soldier injuries, can also apply to perceptual learning classifications. Some possible directions to experiment with that may improve this modules abilities in enhancing learning are to make categories less variable, figure out which exemplars to present when, and the possible decrease in distractors in the initial classification of categories to reduce cognitive load. Influencing individual’s implicit perceptions is an extremely innovative and difficult task. Thus, improving these learning modules could have a significant impact on learning in general.
References


Recognizing Self-Generated Actions in Point-Light Display

Tabitha Safari

Abstract

Despite relatively limited experience with viewing our own whole-body movements, human observers excel in their ability to identify and distinguish themselves among others upon visualization of self-generated actions presented via point-light display. This marked saliency in self-recognition ability provides strong evidence for the contribution of motor representations to action perception. The present study aims to investigate the interplay between motor and visual representations within the self-recognition paradigm by using both simple actions with little variability in movement patterns across actors (e.g., waving) and complex, high variance actions that require more action planning (e.g., dancing). If self-recognition is primarily influenced by motor experience, due to the presumed specificity of motor-action representation for planned actions, we would anticipate high variance actions to be more easily recognized. In addition, if self-recognition is primarily rooted in visual experience, we would anticipate low variance actions to present a more challenging task to self-recognition due to the high-similarity of visual-action representations between individual actors elicited by these actions. To test these hypotheses, we used a motion-capture system to record participants as they performed a series of 18 actions. After 2–3 months, participants were presented with point-light displays of their own actions, alongside the same action performed by three other individuals, and asked to identify themselves in alternating high and low variance action trials. We found significantly above-chance performance in both action categories, but complex actions yielded a significantly higher frequency of correct responses than simple actions, suggesting the contribution of action planning structures to human action perception.
Recognizing Self-Generated Actions in Point-Light Display

Humans are tremendously social beings. Even when we are not actively participating in social exchanges and interactions, we spend an extensive amount of time watching others on the move, day in and day out. With such prolific experience in perceiving and interpreting the actions of others throughout the course of everyday life, it is no wonder why the human visual system displays such impressive sensitivity to human movement. Decades of psychophysical research in biological motion perception have used kinematic displays of human motion to test the extent of this sensitivity, with findings demonstrating that even when stimuli convey minimal visual information (e.g., moving discrete joints in a point-light display), human observers exhibit a remarkable adeptness at deducing patterns of human locomotion from visualization of just a few light points placed along the major joints of a body in motion (Johannson, 1973). The use of point-light displays to depict and understand the mechanisms underlying human biological motion have contributed to a massive literature on the subject, dramatically expanding our knowledge of visual motion perception by demonstrating that human perceptual organization goes far beyond the ability to merely deduce whole-body human movements from a few point lights. In fact, aside from also being able to identify a point-light actor’s gender, emotional state, deceptive intent, and sexual orientation, among other things, human observers exhibit marked saliency in their ability to accurately infer the identity of a point-light actor from mere visualization of their actions alone.

With the exception of when viewing ourselves in a mirror, we encounter very few instances in life that grant us the opportunity to observe our own whole bodies in motion. Yet despite this limited experience, insofar as identity perception goes, when tasked with viewing point-light depictions of themselves, their friends, and strangers performing various actions,
human observers are better able to recognize kinematic displays of their own self-generated actions than they are the actions of their friends in both actor identification and discrimination tasks (Loula et al. 2005). This finding suggests an interaction between motor and visual representations underlying human perceptual organization and highlights the capacity of the human visual system to detect and utilize specific distinctions in movement patterns between different individuals that allow us to effectively discriminate identity and recognize certain actions as our own.

Numerous studies investigating identity perception have found performance in actor identification, discrimination, and self-recognition tasks to be action-dependent, with the best performance found in response to less frequently-occurring, expressive actions (e.g. dancing, boxing, playing Ping Pong) as opposed to more frequently-occurring, familiar actions (e.g. running, walking, jumping) (Loula et al. 2005). In terms of basic level processing of visual information, these results seem pretty self-explanatory as individual actors should be easier to distinguish when performing more expressive, less-constrained actions due to the fact that there is simply more unique information available. Moreover, action-dependent self-recognition performance explains the facilitation effect of recognizing self actions over the actions of others by supporting the idea that each individual’s visual system demonstrates heightened sensitivity for the unique movement patterns and motion signatures evident in the perception of expressive actions performed by oneself. However, we propose that this advantage in self-recognition ability for expressive actions stems not only from the visual system’s presumed optimization for the perception of self-generated actions, but also from the fact that expressive actions tend to employ greater degrees complexity than constrained actions, and therefore require more action planning on the part of the individual actors executing them. It follows, then, that if self-
recognition is primarily influenced by sensorimotor processing, due to the presumed specificity of motor-action representation for planned actions, we would anticipate more complex actions to be more easily recognized upon visualization.

Perceiving the actions, moods, and intentions of others is intrinsic to the development of interpersonal awareness, and visual perception provides a particularly rich source of information in support of this fundamental skill (Blake & Shiffrar, 2007). Therefore, it is safe to say that identity perception not only plays a major role in social development but also facilitates social and emotional awareness of others as well as lays the foundation for more developmentally sophisticated processes such as empathy (Decety & Chaminade, 2003). This begs the question of whether or not self-identification performance declines in individuals with impaired social and empathetic awareness. Extensive research on Autism Spectrum Disorders (ASD) has shown that individuals with ASD tend to possess relatively poor high-level, global processing but superior low-level, local processing of biological motion information than their typically-developing counterparts while those falling within the low-to-normal range of spectrum tend to be automatically and involuntarily attracted to global biological motion information (van Boxtel & Lu, 2013), analyzing images in their entirety rather than focusing on the local elements that make it up.

That being said, if individuals who exhibit more autistic traits than normal exhibit poor global processing abilities in the perception of biological motion but compensate for this deficit with a heightened sensitivity to local motion cues than those with very few autistic traits, will performance within the self-recognition paradigm vary as a function of individual actors’ visual processing ability? If so, since self-recognition performance is action dependent, we propose that using degrees of movement variability as a means for action categorization might provide a
useful framework for understanding why some actions are easier to recognize than others and whether or not self-recognition performance varies across subjects depending on (a) the visual-information processing style (local or global) employed by individual actors, (b) the variability in movement patterns across different categories of actions, or (c) a combination of both.

To test these predictions, we used point-light data to quantitatively measure the variation in movement patterns elicited by different actions across the total set of actors and subsequently divided these actions into corresponding high and low variance categories. We then recruited participants with higher-than-average and lower-than-average numbers of autistic traits—as determined by the results of an autism spectrum quotient (AQ) test—and divided them into two separate groups based on their score (high AQ or low AQ). We used a motion-capture system to record participants as they performed a series of high and low variance actions. After 2–3 months, we presented participants with point-light displays of their own actions, alongside the same action performed by three other individuals of the same gender, and asked them to identify themselves.

We define low variance actions as basic, low-complexity types of actions with little variability in movement patterns across individual actors. These actions are more concrete and tend to be less malleable to subjective interpretation. For instance, imagine asking participants to perform the action, “wave”. There is a very stereotypical way to wave and most participants would likely produce highly similar actions. When later presented with their own waving action alongside the waves of others, it may be more difficult for participants to distinguish their own action because of the low variance, or high-similarity, of action execution between themselves and others. Conversely, we define high variance actions as actions of higher complexity that require more action planning. These actions allow for more expressional freedom and are prone
to subjective interpretation when acted out. For instance, imagine a participant is asked to perform the action, “dance”. This person may have much experience with salsa dancing in comparison to other styles and hence choose to do the salsa. On the same token, other actors’ go-to dance move of choice might be some form of a disco or break dance or maybe even the Macarena, etc.

Low AQ subjects rely on global biological motion information—the “big picture” of the whole-body image—while high AQ subjects tend to exhibit relatively poor global processing that is compensated for by superior local processing abilities—focusing on the individual elements that make up the big picture (i.e. focusing just on the movement of a single limb or the most important joint like the ankle or elbow) (van Boxtel & Lu, 2013). Because they allow for more expressional freedom, high variance, planned actions tend to reflect idiosyncrasies of movement styles between individual actors, thereby making more unique motor-action representations available. This increased availability of unique motor representations translates to increased availability of unique global motion information, and, correspondingly, increased availability of unique local motion cues for each individual high variance stimulus; therefore, we anticipate high variance actions to facilitate overall self-recognition performance for both high and low AQ subjects. On the other hand, due to the high similarity of visual-action representations between low variance actions performed by oneself and others, low variance actions tend to decrease the availability of unique global information; therefore, we anticipate these actions to present a more challenging task to recognition overall. However, because high AQ subjects demonstrate superior abilities in local, detail-oriented processing of relatively simple stimulus features (van Boxtel & Lu, 2013), they might be able to tap into any available local motion cues and extract subtle differences between their own actions and the actions of
others that low AQ subjects might otherwise miss. Ultimately, we anticipate that individual actors will find it easier to distinguish themselves when there is more variability in movement patterns and motor representations between actions as opposed to when there is less variability. Furthermore, while we expect low variance actions to pose a more challenging task to self-recognition overall, we anticipate high AQ subjects to outperform low AQ subjects in low variance action trials due to differences in high and low-level visual processing abilities between groups.

**Methods**

**Participants**

Ten undergraduate University of California, Los Angeles students (8 female, 2 male, $M_{\text{age}}=20.5$ years, age range: 18-35 years) were recruited for a two-part study investigating the role of motor and visual representations in determining self-recognition performance. Participants were compensated financially upon completion of both Part I and Part II of the study. Participants were recruited based on their AQ score, which we obtained following their completion of a pre-study questionnaire consisting of questions derived from a standard AQ test. Participants with a higher-than-average number of autistic traits have many characteristics consistent with ASD and were designated “High AQ” subjects ($25 \leq AQ \leq 50$) while participants with a fewer-than-average number of autistic traits were designated “Low AQ” subjects ($0 \leq AQ \leq 14$). AQ scores ranged from 8-26 ($M_{AQ}=16.9$). We did not ask whether participants were diagnosed with ASD. All participants had either normal or corrected-to-normal vision and demonstrated English fluency.
Part I Procedure

Participants were recorded using an *Xbox Kinect* with built-in 3D depth sensors to capture whole-body motions as they performed a set of 18 actions (nine low variance, nine high variance). Low variance actions included (a) grab, (b) hammer, (c) jump, (d) kick, (e) lift, (f) point, (g) punch, (h) push, and (i) wave. Actions featured in the high variance category included (a) argue, (b) clean, (c) dance, (d) fight, (e) get attention, (f) hurry, (g) play a sport, (h) play a musical instrument, and (i) stretch.

Stimulus Design

The *Xbox Kinect* motion-capture system works by first constructing a depth map of the objects in frame to infer body position and subsequently tracking the x-y-z-coordinates of actors’ skeletal motions at a rate of approximately 33 frames per second in response to the slightest detection of movement. Upon successful recording of each action, the resulting series of frame-by-frame images were converted to point-light representation via *Skeleton Viewer* and *Matlab* applications whereby executed actions were translated into “full-body” animations using 25 dots (light points) to represent and describe the motions of the major joints along the body. Part II Procedure

Two to 3 months after recording, participants were invited back to complete the testing phase, which consisted of a forced choice self-recognition task wherein participants were presented with point-light displays of their own actions, alongside the same action performed by three other individuals, and asked to identify themselves in randomly alternating high and low variance action trials. The 2–3 month gap minimized the likelihood that participants would remember the specific movements that they had performed during the recording phase.
Participants were shown each of the 18 total actions from four different viewpoints—one viewpoint depicting the original action as it was recorded (rotated by 0°) and the remaining three viewpoints depicting the action rotated along the axial plane by 135°, 180°, or 247°, respectively—resulting in 72 trials total. Trial order varied randomly across subjects. Each trial consisted of four side-by-side point-light depictions of the same high or low variance action with one display depicting the participant’s own action and the remaining three displays depicting that same action performed by three distractor individuals. Point-light displays were normalized for gender and height across subjects and distractor displays were held constant across subjects of the same gender—that is, every male participant was presented his own action alongside the actions of the same three male distractors and every female participant was presented her own action alongside the actions performed by the same three female distractors. Actor order varied randomly from trial to trial. After every two trials, participants were prompted to provide a confidence rating corresponding to which of their two previous responses (first or second) they were more confident in, resulting in a total of 36 confidence ratings.

During the testing phase, participants were seated in front of the display monitor in an unlit room. Prior to beginning the experimental task, an experimenter read aloud to participants the task instructions displayed on the Start screen, explaining to them that would undergo a series of action trials, each consisting of four point-light animations depicting the same action performed by themselves and by three other individuals. They were told that their main objective was to identify the point-light animation that depicted their own action. The experimenter then explained to participants that after every two trials, they would be prompted to give a confidence rating based on their two previous responses, and so, to keep in mind how confident they were in each answer choice. Participants would record their responses by using a mouse to click on the
point-light display that corresponded to their action choice. For each trial, actions played back on a loop and remained on the screen for 45 seconds, giving participants plenty of time to provide a response. Once a response was made, participants would move on to the next trial. Trials randomly alternated between high and low variance actions. Participants were never informed which actions counted as low variance and which counted as high variance. A confidence interval screen was displayed after every two trials (one high variance, one low variance), asking participants which of their two previous responses they were more confident in. Participants would click on a box labeled “1” to indicate more confidence in their first choice or “2” to indicate more confidence in their second choice. This would allow us to assess whether participants demonstrated awareness of the accuracy of their own judgments and determine whether implicit or explicit judgments were associated with a either category of action. The entire testing session lasted about 30 minutes.

**Results**

The percentage of correct self-generated action responses across conditions was analyzed using a multilevel logistic regression. Because this was a four-alternative forced choice task, chance performance is 25% correct. We found significantly above-chance self-recognition performance across conditions, but high variance actions yielded a significantly higher frequency of correct responses ($M_{HV} = 67.36$) than low variance actions ($M_{LV} = 62.27$), indicating a main effect of action-variability. Additionally, no significant difference in self-recognition performance between high and low AQ groups was found, so a main effect of actor AQ was not achieved.

We used a chi-square test examine differences in self-recognition accuracy between conditions. We found that self-recognition accuracy in response to low variance actions was
significantly higher for low AQ participants ($M = 55.09$) than high AQ participants ($M = 36.81$), giving rise to a significant interaction between actor AQ and action variability.

**Discussion**

Of the 28 participants we have recruited so far, only 10 have completed both part I (action recording) and part II (testing phase) of our self-recognition experiment to date, with the remaining 18 only having completed part I (action recording). As such, the pattern of results presented in this paper were generated from the responses of only 10 of our 28 total subjects and may not be entirely representative of the pattern of results we might see if we had a larger sample size. In addition, it is important to note that results were drawn with an uneven number of participants in each AQ group (six low AQ, four high AQ); therefore not only were results drawn from an entirely too small sample size, but high AQ subjects were underrepresented, which might explain why overall recognition performance in high AQ subjects was found to be lower than that of low AQ subjects in both action-variability conditions. Ultimately, much more testing is needed before any definitive conclusions can be drawn.

As of yet, self-recognition performance seems to be action dependent. As predicted, participants appear to find high variance actions easier to recognize than low variance actions overall. In addition, of the 18 actions total, low variance actions made up the bottom seven least recognized actions with “punch” and “wave” eliciting the lowest frequency of correct responses across subjects, respectively ($M_{\text{punch}} = 32.5$, $M_{\text{wave}} = 37.5$). Conversely, high variance actions made up the top seven most recognized actions, with “dance” and “stretch” eliciting the highest frequency of correct responses across subjects, respectively ($M_{\text{dance}} = 87.5$, $M_{\text{stretch}} = 75.5$).

Although we found significantly above-chance performance in both action-variability categories, the significantly higher frequency of correct responses yielded by high-variance
actions as opposed to low variance actions suggests the contribution of action planning structures to human action perception. However, as stated before, much more testing is needed before we can make any such conclusion with confidence.
References


Human Performance on the Fluid-Judgement Task

Tiffany T. Tran

Abstract

We examined the human performance on the water-level task through the use of visual motion cues from realistic flow demonstration animations. We hypothesized that these animated demonstrations with latent fluid attributes, such as viscosity, enhance performance in this reasoning task through mental stimulation. Young adults were recruited from the Department of Psychology subject pool at the University of California, Los Angeles. A within-subjects design was made with the independent variables of viscosity and volume for each condition, totaling up to 16 trials per condition. In the study, the relative position of the containers in each image (left or right) and color (red or green) are two variables that should be controlled for. Thus, we have four between-subjects conditions with each condition having 16 trials. Our dependent variable was based on participants’ responses when asked which cup needs to be tilted at a larger angle for the fluid to begin to pour out. Overall, we found that people naturally attend to latent attributes when performing this reasoning task as long as they can observe motion cues from demonstration animations. With more research, one day we may be able to create a mental model that perfectly simulate how humans simulate fluid movements.
Human Performance on the Fluid-Judgement Task

How is it that people interact with moving fluids every day with ease? To start off this investigation, Piaget and Inhelder (1956) conducted a developmental study to examine when children develop a concept of Euclidean space. The authors judged children’s ability to reason about the surface orientation of the water in different containers tilted at different angles. They showed ten year-old children the orientation of an upright container and asked them to draw the surface of the water line for the same container after it was tilted. It was found that children could, in fact, reason about the orientation of water and that the water line should be horizontal regardless of how tilted the container was. The authors concluded that children ten years of age could recognize and attend to the horizontal component of space.

McAfee and Proffitt (1991) proceeded to explore whether Piaget and Inhelder’s (1956) conclusion would be the same for adults as it is for ten year-old children. McAfee and Proffitt (1991) believed that people’s performance on this water level task depended on the way the problem was presented. They believed the traditional water level task relied too much on the object-relative coordinate system. In an object-relative coordinate system, the participant must determine the angle of the water relative to the container. In an environment-relative coordinate system, the participant must determine the angle of the water relative to the horizontal referent (see Figure 1). If presented several containers tilted at different angles to the participant, it motivates attention to an object-relative representation, thus McAfee and Proffitt (1991) sought other ways to modify the water-level task.
McAfee and Proffitt (1991) designed an experiment to promote an environment-relative perspective to the water level problem. They hypothesized that those who tended to evaluate the water level problem with an object-relative perspective would be less likely to adopt the environment-relative representation. Their experiment consisted of water-filled containers in which the water levels were yoked to the orientation of the containers. Thus, the environment-relative orientation became the only helpful variable that could be used. They found that only about 60% of adults could correctly predict the water level. Overall, the authors found that adults perform poorly when asked to make these explicit reasoning judgments.

Schwartz and Black (1999) wondered whether there was a difference between people’s mental simulations and their inaccurate explicit responses. These authors designed an experiment testing whether people could reason about water levels through mental simulation. In the first
part of their study, the explicit task, participants were presented with an image of two containers that differed only in width. The water in each container was filled to the same height. Participants were to judge which container needed to be tilted farther before the water begins to spill out (see Figure 2). Only 34% of participants correctly reported that the thinner container needed to be tilted farther than the wider one in order for the water to be poured. Participants were to then grasp one tangible container at a time (i.e., either the thin or wide cup) with their thumb on an imagined water line and tilt the container with their eyes closed until the imaginary water reached the edge of the container. Surprisingly, 95% of participants correctly rotated the thinner one farther. Schwartz and Black (1999) believed that participants were successful as they mentally simulated the tilting event instead of explicitly coming up with an answer, thus increasing the success rate. Therefore, performance on the explicit task was not predictive of performance on the simulated tilting task.

Figure 2. (Left) Example stimuli for Schwartz and Black’s (1999) basic inferential task. (Right) Cross-section of thin and wide cup with equivalent initial water levels. In each situation, the wider cup begins to pour before the thinner cup.
The results of Schwartz and Black (1999) prompted us to question the variables that operated within these simulated representations. We wondered if people can attend to more latent variables such as viscosity, when building the simulated representation of a fluid. We hypothesized that animated demonstrations with latent fluid attributes, such as viscosity, will enhance performance in the water level reasoning task through mental stimulation.

**Methods**

**Participants**

A total of 153 young adults were recruited from the Department of Psychology subject pool at the University of California, Los Angeles. Students were compensated with course credit for their participation.

**Design**

A within-subjects design was made with the independent variables of viscosity and volume. The experiment consisted of a low viscosity and high viscosity container next to each other across trials. We manipulated the volume of low viscosity and high viscosity fluids in each container with the values 20%, 40%, 60%, and 80%, representing the proportion of the container filled. Thus, the experiment included all possible volume pairs between low level and high level viscosity fluids, consisting of a total of 16 trials. Our dependent variable was based on participants’ responses when asked which cup needs to be tilted at a larger angle for the fluid to begin to pour out. To control any bias in the results, the relative position of the containers in each image (left or right) and color (red or green) are two variables that should be controlled for. Thus, we have four between-subjects conditions with each condition having 16 trials.
Materials and Procedure

The experiment was done through a computer and it begins with demonstration videos of an orange fluid, one not used in the judgement task. The first video shows the fluid pouring over two doughnut-shaped objects looped three times for a total of about ten seconds. This video provides the visual motion cues that inform perceived viscosity. The second demonstration video shows a cylindrical container filled with the same orange fluid tilting at a constant rate from an upright position to the tilted position. Testing trials will begin after this demonstration phase.

Afterwards, two new fluids are introduced, one red and one green. One has low viscosity fluid and the other is filled with high viscosity fluid. Participants are shown a two videos side by side of the red and green liquid being poured over their respective doughnut-shaped objects, similar to the first demonstration video to again show their perceived viscosity from these visual motion cues (see Figure 3). In the following reasoning tasks, participants view a static image of the two containers, one filled with green fluid and the other filled with red fluid. They are asked that if both containers are to be tilted at the same rate as the orange fluid in the demonstration video, which container will need to be tilted farther before the fluid inside begins to pour out. After receiving the participant’s response, another static image appears with the same red and green fluid filled at different heights than the image beforehand and this begins a new trial. The experiment ends when all 16 trials have been completed.

Results and Discussion

This experiment was updated from that of Kubricht, Jiang, Zhu, Zhu, Teropoulos, and Lu (2015). What we added for our current experiment is to control for the possible bias of the relative position of the containers in each image (left or right) and color (red or green), creating
four between-subjects conditions. Our results found was supportive of the results found from Kubricht et al. (2015). When the volume of high viscosity fluid was the lowest (20%), participants consistently reported that the high viscosity fluid needed to be tilted farther before water could be poured out regardless of the volume of the low viscosity liquid (see Figure 4). When high viscosity fluid was the highest (80%), the volume of low viscosity fluid significantly impacted participant responses. When the volume of the low viscosity and high viscosity fluids were equal, participants chose that the fluid that needs to be tilted at a larger angle before fluid begins to pour out depends on the volume of the containers—the proportion of participants choosing the high viscosity fluid when its volume is 60% and 80% was significantly more than the proportion of participants choosing the high viscosity fluid when its volume is 20% and 40%. In all equal-volume trials, one would expect that the high viscosity fluid-filled container always needs to be tilted farther than the container with low viscosity fluid, but these result indicate otherwise. This suggests that people do not solely rely on this heuristic rule to reason about the pour angle of two containers. Rather, we believe that people appear to reliably employ mental stimulation strategies when performing our viscous fluid-pouring task.

In conclusion, we can see that people naturally attend to latent attributes, such as viscosity, when performing reasoning tasks regarding fluid states, as long as they observe visual motion cues from realistic flow demonstration animations. Though our model provides us an explanation of behavioral results at a computational level, we have yet to figure out how our model relates to what humans are actually doing. In other words, our model requires thousands to simulations to arrive at an estimate that supports the judgements people make regarding this experiment, but it is unfeasible to assume that the human brain does the same. In conclusion, we
hope to one day be able to create a mental model that perfectly simulates how humans judge fluid movements.

Appendix

Figure 3. Two new fluids are introduced, one red and one green. One has low viscosity fluid and the other is filled with high viscosity fluid. Participants are shown two videos side by side of the red and green liquid being poured over their respective doughnut-shaped objects.
Figure 4. High viscosity fluid response proportions for all conditions in our current experiment. The volume of the high viscosity fluid (VHV) is plotted on the horizontal axis, and separate lines indicate four possible volumes for the low viscosity fluid (VLV).
References


Mechanisms of Transcranial Direct Current Stimulation

Vivian Liao

Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation technique in which a current of one to two milliamps is run between two electrodes placed on the surface of the scalp. TDCS has received a lot of interest as a tool for modulating cortical excitability and behavior in both clinical and experimental settings. It is well tolerated, painless and inexpensive. TDCS produces excitability changes in the cortex, and interest has grown in its use as a tool in treating neurological diseases related to over or under excitability in the cortex. Thus far, tDCS has been investigated in treating depression, stroke, addiction, and chronic pain. It has also been utilized in research to elucidate the functions of separate brain regions. In addition to use in research, it is currently being sold and advertised, not under FDA approval, as a cognition booster for the gaming community.

In a series of experiments on adult cat brains, an early study by Creutzfeldt et al. 1962 showed that passing direct current through the cortex has the potential to influence the activity of underlying cortical neurons. Electrical activity was measured using EEG, with the reference electrode applied to the frontal skull. Overall, three-quarters of the neurons observed within a three millimeter radius showed a response. The study showed that inward, surface-positive current increases spontaneous discharge rates, while an outward, surface-negative current inhibits discharge rates.

Nitsche et al. (2003) examined the influence of ion channels and receptors on hyperpolarization and depolarization of cortical neurons by tDCS. The study investigated the impact of carbamazepine (CBZ), a sodium channel blocker, flunarizine (FLU), a calcium
channel blocker, and dextromethorphan (DMO), a NMDA receptor antagonist, on cortical excitability. Thus the study examined the dependence of intracurrent excitability modifications on changes of ion-channel conductivity using CBZ and FLU, and the involvement of NMDA receptors in the generation of intracurrent effects by antagonizing NMDA receptors with DMO.

A previous study had determined that 4 seconds of stimulation results in an excitability change without after-effects, whereas stimulation for nine to thirteen minutes will generate after-effects lasting for about an hour after the end of stimulation (Nitsche and Paulus 2000). Thus eight experimental groups of eleven to fourteen healthy subjects were used, with each group receiving CBZ, FLU, DMO or a placebo, and having either short-lasting or long-lasting tDCS administered.

Effects were quantified using transcranial magnetic stimulation (TMS) to measure motor evoked potential (MEP) amplitudes of the stimulated region before and after tDCS for each condition. The results showed that during anodal stimulation, blocking voltage-dependent sodium channels eliminates the enhanced excitability, while blocking calcium channels diminishes it. Blocking ion channels had no effect on the hyperpolarizing effect of cathodal stimulation, possibly due to the inactivation of sodium and calcium channels by cathodal stimulation and the resulting hyperpolarization. For example, the action of CBZ is voltage-dependent, and as such the effect is enhanced when the membrane potential is decreased, and absent when the membrane is hyperpolarized. Antagonizing the NMDA receptors using DMO also showed no effect on either anodal or cathodal immediate excitability changes. Thus, the immediate effects of anodal tDCS on neuronal excitability are likely mainly dependent on ion channel conductivity.
To further examine the mechanisms of tDCS effects, Nitsche et al. (2005) performed a study exploring the modulation of excitability by tDCS in the human motor cortex. TMS protocols were used to test specific neuronal systems in the motor cortex and compare the short and long term effects of tDCS on motor cortex excitability. Active and resting motor thresholds (MT), defined as the minimum TMS intensity resulting in motor evoked potentials during muscle relaxation and contraction, reflect neuronal membrane excitability. Additionally, input-output curves (I-O curves), which take the slope of MEP amplitudes compared to increasing TMS intensities, reflect the recruitment of larger neuronal populations.

Short-term tDCS had no effect on MTs, possibly because tDCS may have modulator activity on intracortical neurons only, and MT depends on cortical as well as cortico-spinal neuron polarization. Long-term tDCS also had no effect, since after-effects of tDCS seem to be based on NMDA receptor efficacy and MTs are not influenced by NMDA receptor modulation. Results of the I-O curve confirmed the finding that anodal tDCS enhances cortico-spinal excitability and cathodal tDCS diminishes excitability. The slope of the I-O curve increases with anodal stimulation, and decreases with cathodal stimulation. In addition, there seems to be an upper bound on membrane excitability, and anodal tDCS only enhances excitability when tested with moderate TMS intensities, supporting the membrane polarization mechanism hypothesis. The difference in results from MTs and I-O curves is likely due to the fact that measurement of I-O curves activates a slightly larger neuronal population compared to MT testing. Thus this study further confirms that short-term tDCS effects are critically dependent on membrane polarization, rather than on synaptic modifications.
Prolonged tDCS can result in various after-effects, the most significant of which is modulation of neuroplasticity. NMDA receptors are crucial to the induction of long term potentiation, as are changes in intracellular calcium levels. Application of sodium channel blocker CBZ and calcium channel blocker FLU selectively prevented the after-effects of anodal stimulation (Nitsche et al, 2003), suggesting that similar to short-lasting tDCS, the after-effects of anodal stimulation are sodium and calcium channel dependent. Application of DMO eliminated both anodal and cathodal after effects, suggesting that the NMDA receptor, which is blocked by DMO, is crucial to induction of the after effects of long-lasting tDCS, regardless of the polarity. In addition, NMDA receptors are voltage-sensitive, so an increased inward current, such as the one caused by anodal tDCS or by open sodium channels, will help to mediate an increase in synaptic strength.

Other than mediating NMDA receptor efficacy, tDCS also affects extracellular dopamine levels. Tanaka et al. (2013) performed tDCS on rats and examined changes in serotonin and dopamine levels using in vivo microdialysis. In vivo microdialysis involves inserting a cannula into the region of interest to locally measure compounds. Three samples were collected from the striatum before the application of tDCS and samples were collected every ten minutes for 400 minutes following stimulation. Rats were exposed to anodal, cathodal, or sham stimulation for ten minutes. Cathodal stimulation induced a significant increase in extracellular dopamine levels in the rat striatum, suggesting that cathodal tDCS has some effect on the dopaminergic system. There was no effect of cathodal stimulation on serotonin levels, and anodal and sham tDCS had no significant effect on either dopamine or serotonin.
In another study on modulation of cortical neurotransmitters by tDCS, Stagg et al. (2009) used magnetic resonance spectroscopy (MRS) to measure changes in cortical neurotransmitter concentrations. In the first experiment, eleven participants underwent three scanning sessions each, receiving anodal, cathodal, or sham tDCS in a random order. Each session was at least 48 hours apart. MRS data was acquired using an MRI scanner at 3 Tesla for fifteen minutes before and twenty minutes after, but not during, a ten-minute period of tDCS. In the second experiment, seven participants received cathodal stimulation, with MRS data collected at 7 T and analyzed for glutamate, glutamine, and creatine. In the third experiment, seven participants received anodal stimulation and were scanned at 3 T, looking for changes in creatine levels. Anodal stimulation resulted in a significant decrease in GABA concentration in the rat cortex. Inhibitory, cathodal stimulation yielded a significant decrease in glutamate, and a correlated decrease in GABA.

Our study involves applying tDCS to the left rostrolateral prefrontal cortex (RLPFC) to examine the mechanisms of executive control over episodic memory retrieval and analogical reasoning. The left RLPFC has been implicated in higher order control of memory and reasoning. The study is conducted over two consecutive days. During the first day, participants perform a memory-encoding task and learn and practice the tasks they will perform while undergoing stimulation on the second day. During the memory-encoding task, participants are asked to create visual memories of stimuli in the context of self or other. Participants are tested on these words during the memory portion of the cognitive task. During another subtask, participants make semantic judgments about the relationships between word pairs. The final subtask requires participants to make quickly select which of four words has the greatest number of straight lines. These subtasks test memory, reasoning, and perception respectively.
References


This quarter, one important task for the team was to recruit new families for interviews and observations. It was through this process that I realized how difficult it is to conduct an observational study. Compared to an interview, a child observation seems to be a much larger commitment for most potential participants that I have contacted. Another assignment that I found challenging was matching our interview excerpts with questions raised by other researchers. The codes that we have been using for our transcripts have different emphasis and are sometimes more comprehensive than the questions that Braten et al. (1999) asked during their interviews. For example, Braten et al. (1999) only counted instances of parents’ or siblings’ observed reading for pleasure as a form of modeling behavior, whereas we included any literary activities or practices carried out by family members for leisure or for work. Katzir, Lesaux, and Kim’s (2008) codes do not include parents’ or children’s attitudes toward literacy related activities, which we believe are an important component of home literacy environment (HLE). It is always helpful to compare the similarities and differences between their approach and ours, to get a sense of which questions we are trying to address through our interviews, and which codes that we need to justify and defend.

Through transcribing and coding the interviews, I noticed a lot of family, parent, or child activities and practices that are in line with children’s cognitive development in the literature. In this paper, I will discuss two of the activities or practices, namely shared reading and Internet use.

Shared reading is a recurring theme in the interviews. Most of the parents interviewed had some experience of reading to or with their child at various developmental stages. Some of
the parents would have their children sit beside them and read storybooks to them. Other parents have stopped reading to their children and instead let them read on their own as a part of their bedtime routine. In one family, the older sister, who is an avid reader, would sometimes read to her younger brothers before bed or after they wake up. If the younger ones have to read, she will listen to them instead. Another family used to bring their children to the library for story time when they were little. There was a mother would read the same book with her daughter at the same pace. Her daughter sometimes requests that they take turns to read out loud. Afterward, they would have a small discussion about the book. The parent explained that the purpose of the discussion is to make sure that her children are not rushing through the readings, but rather enjoying and understanding them.

Shared reading is not only a good opportunity to improve children’s literacy and language abilities, but also a natural context to promote parent-child discussion on social-cognitive events. A study conducted by Aram, Fine, and Ziv (2013) investigated the effect of an intervention designed to encourage parents and four- to five-year-old preschoolers to refer to the plot and socio-cognitive themes of storybooks during shared reading. Their participants were 58 families with low socioeconomic status. All parents were assigned to read an equal number of books to their children. Parents in the control group received no further instruction, whereas parents in the experimental group were taught to read the books interactively with their children based on Bruner's (1986) model. The were guided to first focus on the story plot, including vocabulary, sequence of events, and structure of the story. Then, they were instructed to draw their child’s attention to the socio-cognitive themes of the story, including mental terms, mental causality, and references to the child's life. The results showed that parents and children in the experimental group referred to the plot and the socio-cognitive themes of the stories significantly
more than the control group did. This increased reference has been associated with many benefits to children’s cognitive development. De Temple and Snow’s (2003) study has shown that references to books’ vocabulary and plot are related to children's vocabulary. Dickinson and Porche (2011) found that having rich and engaging conversations with preschoolers about stories predicted their reading comprehension skills in fourth grade. Furthermore, drawing children’s attention to the books’ socio-cognitive themes guides children to better understand the social situations and the characters’ thoughts and feelings. Conversations about the socio-cognitive aspects of a story are also related to children's emotional and social development (Adrian et al., 2005). Relating the characters’ emotions, beliefs, and desires to children’s personal life experiences can improve their understanding of social situations and their own mental states (Dever & Burts, 2002).

In our parent interviews, the parents were not explicitly asked whether they structured their shared reading sessions in a systematic or unguided fashion, or whether they merely read the stories word for word or elaborated the stories beyond text. Since the children in our study came from third to fifth grade, they are expected to have more vocabularies and better comprehension skills to read independently. On the one hand, they experience less direct guidance on reading from their parents, and therefore might enjoy less of the aforementioned cognitive, emotional, and social benefits from shared reading. On the other hand, they might have already developed the habit of paying close attention to the theme of the story and the emotions of the characters, and independent reading would train their comprehension skills. It is interesting that some children do prefer that their parents read to them and discuss the stories with them. They might metacognitively know that parental guidance would help them better understand and thus enjoy the stories.
Another recurring theme in our interviews is the Internet as a tool that parents and children use to find information for homework, school projects, or general interest. When asked about what they do to look for an answer or information, all 15 parents that were interviewed gave the Internet as a standard response. Many parents said that their children use search engines, such as Google, and online dictionaries, such as Merriam-Webster. One parent mentioned that her son “does a little bit of dictionary…But he’d rather go…online.” Another parent said that to answer questions or find information, they would first encourage their children to ask the parents and consult the dictionary or encyclopedia. If they cannot get an answer from these sources, they would go online to search for the information. Some parents will try their best to give their children a general idea, before consulting the Internet to fill in the details, whereas for other parents, the first thing they do is to Google the information. From what the parents said, school teachers encourage students to use the Internet in school or at home for research, and often provide the students with useful links to the websites. Some parents would go over safe Internet use guidelines with their children before letting them go online by themselves. Some parents would also supervise and guide their children during online research.

The prevalence of Internet use in the 15 families interviewed in our study calls attention to how efficient children actually are in conducting online search. Barrett (2012) examined fourth graders’ information-seeking behaviors using the Internet for school assignments and underlined the need for efficient search strategies. She conducted a qualitative study on 13 fourth grade students’ search behaviors in an elementary school library using data collection methods including think-aloud observations, interviews, think-afters, final projects and Independent Reading Level assessment scores. The children were instructed to verbally describe their actions and thoughts during Internet searches. Their comments, behaviors, and the computer screens
were video-taped and later coded to identify themes and patterns regarding the children’s approach to search for information. All 13 children were found to use Google to search for information. There was a variation in their ability to locate relevant information. Barrett also examined the relationship between children’s information-seeking behaviors and factors such as reading abilities. Low level readers were found to enjoy reading online. Search strategies were found to be influenced by multiple factors including assignment questions, search engine tools, and age appropriate websites. Barrett proposes that students need formal training and guidance on Internet searching skills to optimize the benefits they obtain from online sources.

Similar to Barrett’s (2012) study, the questions in the parent interview in our study focused on parents’ and children’s information-seeking behaviors, which turned out to be heavily Internet-based. Other than information searching, children’s other forms of online activities can be directly or indirectly related to their literacy and cognitive development as well. Blackwell, Lauricella, Conway, and Wartella (2014) examined the content and types of activities that children engage in online. They looked at 442 8- to 12-year-old children’s Internet content preferences and found that YouTube and Facebook were the most favored websites. This pattern of preference has important implications to children’s cognitive, emotional, and social development. The increasing amount of time spent on social networking sites influence children’s social behaviors, such as their desires and efforts to fit into a certain group of peers. Many children under 13 years old report using Facebook although not meeting its minimum age restrictions. Many also use other social networks on a regular basis (Rideout et al., 2010). The shift to forging a closer relationship with peers while distancing themselves from their parents (Huston & Rikpe, 2006) influences children’s emotional development as they gradually discover their individuality and form their unique self-concept (Feldman, 2009). In terms of cognitive
development, children at this age learn to discriminate between fictional media content and reality (Dorr, 1983). It is important to understand how children’s online experience, such as watching YouTube videos, influences their understanding of the world around them. Media use has been traditionally believed to be influenced by children’s developmental stage. At the same time, Blackwell et al. (2014) believe that children’s development can be influenced by their media use too. They suggest that visiting age-inappropriate websites might speed up children’s social development when their cognitive and emotional stages are not mature enough to be exposed to such informational content. They believe that earlier media literacy education is needed to ensure that children engage in developmentally appropriate activities online.

Shared reading and Internet use are just two of the HLE components that heavily influence children’s cognitive, social, and emotional development. We could use our existing data to examine how these two factors, together with other HLE activities and practices, are related to children’s development, academic performance, and relationship with their family.
References


