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EDITOR'S NOTE

It is with pleasure and excitement that we present Volume IV of the Koç University Undergraduate Psychology Journal. Our goal in creating this journal was to establish a platform in which undergraduate psychology students could share their research with one another, and most importantly we wanted this platform to be available to everyone, not just Koç University students. In our second Issue we covered articles from *Yeditepe University* and *Middle East Technical University*, and in our third issue an article from *University of Durham* was included.

We happily announce that in this Issue we present articles from *Kadir Has University* and from *Pomona College, California*. It is a pleasure for us to see that fellow undergraduates from other universities share their research with us, and we hope to include more articles from different universities. While we can only print a small portion of the articles we receive, as the KUUPJ team we are very thankful for those who have submitted their work, and we hope to include these articles in our later Issues.

First of all, I want to thank my wonderful team for their effort in creating this fourth issue. With this issue our team has increased to nine hardworking editors. All of the editors volunteered hours of their time to review articles and enhance the work of fellow students. I also want to thank our advisors Dr. Tilbe Göksun and Dr. Fuat Balcı. Without their support and guidance this platform would not be established. In addition, I would like to present my gratitude to the Koç University Psychology Department with its entire faculty who supported our journal and this issue throughout the process.

Lastly I want to thank to all authors and undergraduate students who shared their work with us, as their research is the foundation of this journal.

As the journal team we hope that you will enjoy this issue, but more importantly we really hope you to be inspired to share your research with us!

Editor-in-chief

Eylül Turan

Change Detection Performance in Location and Object Change

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Change detection is a function of visual attention and requires the persistent recognition of stimuli during the processing of the visual surrounding in terms of changing characteristics, onset and offset objects. Change blindness is a striking phenomenon that can be explained as missing the specific alterations in the visual field. The missing details of changed stimuli may interfere with change detection performance. In the present study, influence of type of change and load of change were examined on the accuracy and reaction time scores. Results indicated that reaction times in object (feature) change condition were significantly faster than location change condition. Also detecting three-change required less time than one-change alterations. In addition, accuracy of location change is higher than object change accuracy, and inconsistent with the prediction three-change accuracy was lower than one-change accuracy. Participants were not found to be sensitive to the specific task, in terms of type and amount of change. The correlation of accuracy and reaction time scores were independently examined with participants' daily cognitive mistakes, and the results were insignificant. In line with the findings of previous studies, participants reacted faster to the change when there is more alterations in their visual field but with decreased accuracy. Moreover, detecting location change required more time with higher accuracy scores than feature change detection.

Keywords: change detection, change characteristics, visual attention, change blindness

In daily life, we encounter various situations that invoke different attention processes with great amount of stimuli. This complexity of the visual information challenges human capacity to process all information. Eventually, the complexity of the loaded information forces the capacity to select relevant information for cognitive processes, and this working mechanism is called visual attention (Fecteau & Munoz, 2006). We collect visual information from our environment and process it according to some mechanisms. One of the mechanisms is task-oriented or goal-driven, other one is saliency based stimulus-driven information processing (Fecteau & Munoz, 2006; Ludwig & Gilchrist, 2002). Saliency based visual attention occurs when an object captures one's attention involuntarily, or according to the stimulus' saliency in the visual field. In goal or task oriented visual processing, individuals search voluntarily or for what is important in their visual field (Berger & Henik & Rafal, 2005). For example, saliency based attention can be explained by recognizing the umbrellas or beach balls while you are walking around the coast, without the specific intention to see them. However, if you expect to see and look for a beach ball to play with while you are walking within the same context, and luckily you recognize an attainable one in your sight, such an instance is an example of goal-oriented visual attention. The selection mechanisms of visual attention allow people to gather related visual information to their pertinent visual field. Stimulus-driven information can be collected from the briefly changing environmental stimuli or newly appeared onset (Fecteau & Munoz, 2006). For example, one can realize a new object in a room or detect the changed

location of the object. On the other hand, when the stimulus is gone, replaced, or located to a new place, people sometimes cannot recognize the change.

Change blindness refers to failure of noticing obvious changes when attention is preoccupied with other stimuli or directed at specific feature or location (Simons & Ambinder, 2005). Visual attention is required to detect the change as some features or the locations are altered for detection (Boyer, Smith, Yu, & Bertenthal, 2011). It occurs when unattended objects change (both feature and location) without capturing our attention (Smith, Lamont, & Henderson, 2012). Additionally, great load of stimuli may lead individuals to miss some alterations in the visual field (Mack, 2003; Rensink, 2005; Simons & Ambinder, 2005). The underlying mechanism can be explained in terms of limited capacity of the visual perception, such as limited capacity to encode, retain and insufficient comparison of the changing material, in one glance to the next one (Simons & Ambinder, 2005).

A study indicates that change blindness may occur because of the failure to compare existing representations between pre and post change scenes (Simons, Chabrisa, Schnura, & Levin, 2002). In Simon's and colleagues experiment (2002), although the individuals could not detect the major change such as removal or addition of a stimulus, they could recall the details of the first (or pre) scene they saw when they were directly asked. In addition, people may detect the change even if they do not think they detected them, meaning that, comparisons of visual representations may still be intact. Another study similarly indicated that, preserved representations can be reported explicitly even if change goes undetected (Mitroff, Simons, & Levin, 2004). In this study participants saw the pre and post change arrays. Then, they had the two alternative forced choice (2AFC) task which is used to understand whether there were preserved representations of the altered visual scene. In the task, both pre, post changes and unchanged objects were given to participants to select the correct answer by identifying between two alternative choices. After the task, they were asked to report whether they had detected any change or not while trying to not to infer from the previous answers to the alternative choice task. Results demonstrated that, even if participants had stated that they did not notice the change, they were able to report the changed objects correctly in 2AFC task. This result may indicate that change blindness may arise from the failure of comparing representations although the individuals have adequate information of pre and post scenes.

According to several studies, low capacity of visual working memory (VWM) is responsible for experiences of change blindness due to low capacity to process the information (Koivisto & Revonsuo, 2009) To measure working memory (WM) capacity, Operation Span Task (OSPAN) is used to detect the controlled attention which is a domain of executive functioning. Therefore, low scores in OSPAN task is correlated with low WM capacity (Hannon & Richards, 2010). In OSPAN task, individuals are expected to solve arithmetic equations, memorize the presented letter, and then recall them in order (Beanland & Chan, 2016). Specifically, this task measures participant's cognitive flexibility, which is the ability to manage between different ongoing attentional demands (Glass, Maddox & Love, 2013). However, WM and change detection studies have some conclusions that contradict each other and several studies claim that there are other factors such as individual differences, which influence change detection performance rather than working memory capacity (Beanland & Chan, 2016; Bredemier & Simons, 2012). Furthermore, it is inferred that during high load WM conditions, individuals are more prone to detect the change, which contradicts with WM literature (Fockert & Bremner, 2011). The present study's motivation was derived from this contradictory effect and number of changes was a factor that was tested.

Individuals' performance in change detection studies is open to question because the detection may occur by the conscious process or chance. To extricate the answers that are obtained by chance or conscious process, Signal Detection Theory (SDT) is widely accepted and used in the field, which aids to investigate whether participants differentiated between the signals (correct hits) and noise (chance factor) (Stanislaw & Todorov, 1999). This measurement is reached by standard deviation units. d' represents sensitivity of detector and β is a

criterion. The higher the d' value is, the more sensitive people are in discrimination. ß criterion shows whether the participant is inclined to answer the questions in a specific way (response set). The concept enables researchers to measure response bias and sensitivity of participants. Therefore, to discriminate the hits, misses, correct rejections, and false alarms, using d' analyses in the change detection paradigms has been widely accepted (Hannon & Richards, 2010; Mitroff, Simons & Levin, 2004).

First, the study hypothesized that reaction time would be longer for object change condition than location change condition because of the altered location information dominating altered object identity information (Becker & Rasmussen, 2008; Scholl, 2000). Therefore, the first hypothesis of the study was that reaction time should be slower in object change than location change detection. Second hypothesis was about the response time of the detection with respect to changing number of features, in other words, noticeability of change, which depends on the amount of alterations in the visual field. The literature about change detection indicates that increased density and saliency of alterations in the visual field facilitates the detection process (Scholl, 2000). In both location and object change conditions, the present hypothesis is that the decrease in the amount of change would require more time to detect, therefore increased reaction time. In short, in one-change condition, reaction time should be greater than three-change condition for both object and location conditions. The third hypothesis is that the accuracy rates would be higher in location change than the object change detection, in accordance with Cole's study (2003). Similarly, with the visual field perspective, and with the addition of Fockert and Bremner's (2001) study, enhancing visual load may lead to improved stimulus detection. Fourth hypothesis was about the accuracy rates due to alterations in number of the changes. In both location and object change conditions, the prediction was that the increase in the amount of change would predict more correct answers and therefore increase accuracy rates. In other words, accuracy rates would be higher in three-change condition than the one-change condition. Additional hypotheses were generated according to the subjects' answers towards their cognitive failures in real life settings, and sureness about their answers. The present study's prediction was that, people who have low accuracy rates and faster reaction time in the experiment (due to reacting fast without paying adequate attention), would experience cognitive failures in their daily lives more. Additionally, they should be less sure about their correctness in the experiment. However, in the trend of reaction time, speculations can be made because the fact that an individual acts faster than normal does not have to imply that the individual usually makes mistakes in daily life.

The aim of the study was to measure the factors that invoke change blindness or change detection in terms of amount of change and type of change. In other words, the factors and facilitators that make people detect the changes in their visual field are questioned. Dependent variables were reaction time, accuracy, d', sureness scale, and a written change detection (yes/no) given at the end of the experiment.

Method

Participants

72 participants from Kadir Has University and 8 participants from other universities (N = 80) participated in the study voluntarily, there were 49 females and 31 male participants. Their ages ranged from 18 to 24 (M = 21.86, SD = 1.36).

Materials

During the experiment in total 100 arrays, with 6 pictures in each of them, were shown. The pictures belonged to 7 various contexts including baby's room, kitchen, bathroom, bedroom, outdoor, living room, and stationery materials. 140 pictures were used (20 per each category), 120 of them were used to construct 6 item based sets, 20 of them were used to create original sets, for no change conditions.

Distance between computer and the participants were approximately 60 cm. The background color of arrays was white. The experiment was programmed in Psychopy Builder 1.84.2 version (Peirce, 2007).

Cognitive Failure Questionnaire (CFQ) was originally constructed by Broadbendt and colleagues (1982) with Cronbach's alpha coefficient of .89. Turkish version of CFQ (Şenkal, et al., 2015) was given to the participants (See Appendix E). CFQ is a 25 item questionnaire that measures participants' perceived cognitive failures in daily life. The questions are answered in five-order response scale (from 1 to 5). Turkish version of CFQ was found to be valid and reliable to administer on university students, according to the test – retest reliability analysis, Cronbach's alphas were .90 and .93 respectively (Ekici & Uysal & Altuntaş, 2016). In addition, a form was given to rate sureness about participants' own responses. Later, if they detected any change, they were asked to describe which components were changed (See Appendix F). Their sureness score (from 1 to 7) was taken into account according to their own written reports. Perceived detection was derived from their own nominal report, and dummy coded as binary, in the form of detecting or not.

Procedure

Participants were tested in the experiment rooms with 4 people in one room and another separate room for 1 participant. Participants gave informed consent prior to their participation and then told about the task. The task required them to detect changes between pairs of pictures on arrays, which were separated by fixation point. Once the fixation point appears on the screen, it indicates upcoming pair of stimuli (array). Participants were not informed about the nature of change, whether the change is location or feature (or object) oriented. They were only asked to respond based on the instructions regarding the absence or presence of change and be fast and accurate as they can be. One trial consisted of two picture arrays. Every picture array was demonstrated for 1000 ms on a white background with a response deadline for 1500 ms. Fixation screen was presented between two trials for 1000 ms. Prior to the experiment, a practice session consisting of a block of 5 array pairs with change and no-change picture set sizes of two was run to familiarize the participants with the task. Whereas the experiment itself consisted of 4 blocks in 5 trials, with 20 pictures for each category in total 140 pictures within arrays. Four blocks were displayed sequentially for each participant, every block had 240 displays. 80 pairs of displays (with stable set of 6 items on them) were shown. Meaning that, when the display of fixation point was removed, each person saw the 160 picture displays in one block. In total, participants were presented 640 picture displays, and they responded 320 pair of picture displays for four blocks. There were four different change conditions including one object feature change, one location change, three feature change and three location change, and the conditions were scattered in each block. The trials in each block were constructed and therefore they were sequential, but the blocks were randomized. In between blocks a short break was presented. The blocks were randomized.

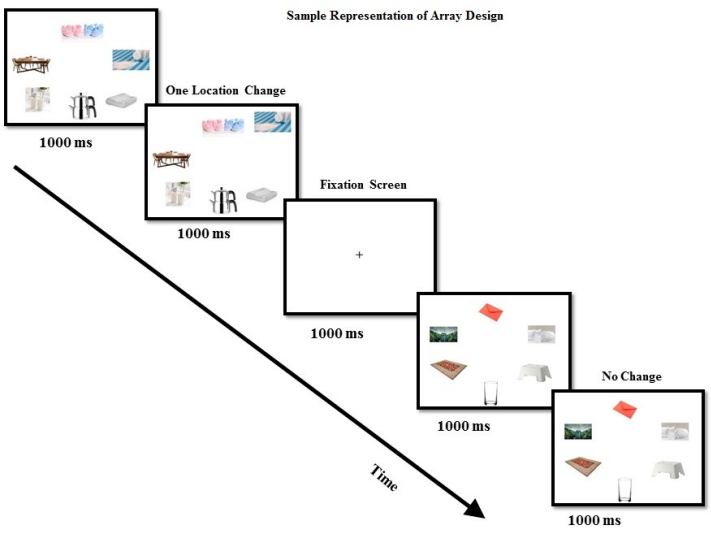

Figure 1. The depiction of array design (displayed as one-location change and no-change conditions): there are four change (location (one or three) and object (one or three)) conditions and one no-change conditions. The arrays were consisted of six items for each representation.

At the end of the experiment, participants were administered the Cognitive Failure Questionnaire (Şenkal, et al., 2015) and a change detection form. In CFQ, they reported their daily life cognitive failures, and in the detection form they reported whether they detected any change or the changes they were aware of, in paper and pencil format. The experiment session lasted approximately 45 minutes.

Results

Repeated measures analysis of variance (ANOVA) was run for in-group differences of participants in terms of reaction time, accuracy and d' separately. The design of the study was 2 x 2 within-subjects factorial design and analysis conducted for type (2 conditions as they were object, location) and number of changes (2 conditions as they were one change, three change). Bivariate correlation analyses were used to check the congruence between the subjects' CFQ results, sureness, change detection reports and their accuracy and reaction time scores in the experiment.

A repeated measures ANOVA indicated a significant main effect of change type on reaction times F (1, 78) = 40.970, $p < .001$, $\eta^2 = .344$. Bonferonni correction was used and it showed that reaction time in the object change condition (M = .646, SEM = .01) was faster than the location change condition (M = .723, SEM = .02). The result did not support the first hypothesis of the study, change detection required less time in object change condition. In addition, manipulation of the number of change showed a main effect on reaction time scores, F (1, 78) = 58.482, $p < .001$, partial η^2 = .428. Post-hoc test was conducted to see the trend of differences which occur between groups. One-change condition's reaction time (M = .706, SEM = .02) was significantly slower than the three-change condition's reaction time (M = .666, SEM = .01) which supports the hypothesis. The results revealed all of the reaction time scores for one-object change condition (M = .655, SEM = .016), for three-object change condition (M = .634, SEM = .01), for one location change condition (M = .752, SEM = .016), and for three-location change condition (M = .690, SEM = .016). There was a significant interaction between change type and amount of change F (1, 78) = 7.962, p = .006, partial η^2 = .093. The interaction effect can be observed as from one change to three change conditions, there is a declining difference between object and location change (See Figure 2).

There was a marginally significant main effect of object change on accuracy according to the repeated measures ANOVA results, F (1, 78) = 3.894, p = .052 with partial η^2 = .048. Bonferonni correction indicated that accuracy in object change condition (M = .82, SEM = .01) is lower than location change condition (M = .85, SEM = .02). Secondly, there was a main effect of amount of change on accuracy scores F (1, 78) = 5.314, p = .024, partial η^2 = .064. Further analysis was conducted with Bonferonni correction. Results indicated that one-change condition's accuracy rate (M = .84, SEM = .02) was higher than the three-change accuracy scores (M = .83, SEM = .01), which was incongruent with the hypothesis. Accuracy of one-object change (M = .83, SEM = .02) was greater than three object change condition (M = .81, SEM = .02). However, in one and three location change conditions, there were no significant differences, (M = .85, SEM =.02). Although significant results were obtained in accuracy due to change type manipulation (object or location), insignificant difference of accuracy scores in one-object change condition and one-location change condition needs to be explained. There was a meaningful interaction between the amount of change (one or three) and change type (location or object), F (1, 78) = 5.921, p = .017, partial η^2 = .071 (See Figure 3).

There was no significant main effect and interaction with type of change F (1, 77) = 1.030, p = .313, η^2 = .013 and amount of change F (1, 77) = 1.071, p = .304, η^2= .014 in terms of d' value. Therefore, none of the hypotheses were supported

Additional correlational analyses were conducted regarding sureness scores and CFQ scales. The results showed that there is a negative significant correlation between sureness (M = 4.40, SD = 1.06) and CFQ scales (M = 1.50, SD = .49) with the value of r = -.380, $p < .01$. Moreover, it indicates that participants are moderately sure about their answers and make few cognitive errors in their daily lives. Accuracy, reaction time, sureness and CFQ scale results showed insignificant correlations, sureness, CFQ and other dependent variables are not related.

Discussion

The aim of the study was to examine the change detection performance under different

conditions to test which amount of change goes undetected and which changes are detected. The conditions were type of change (location or object) and amount of change (one or three change).

The study revealed the opposite of the first hypothesis, participants detected the change more quickly when the change is feature based rather than location based.

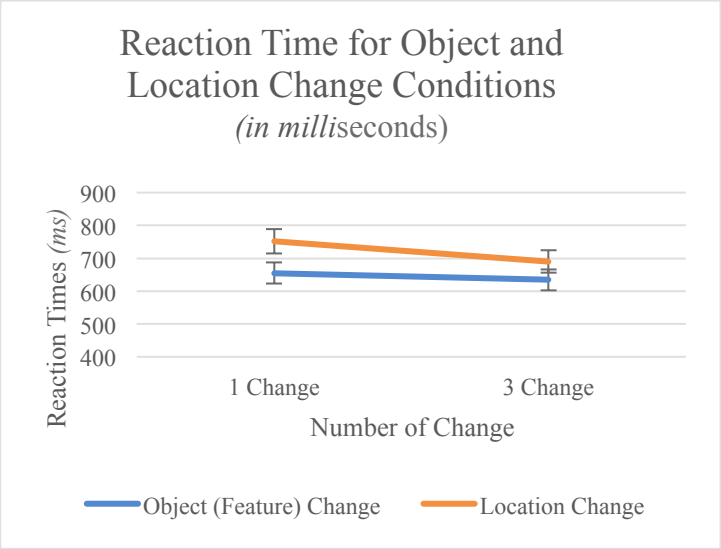

Figure 2. The graph shows the significant interaction effect of change types (object/feature and location conditions) and amount of change (one-change and three-change) on reaction time. The interaction indicates that with the increasing of amount of change, object (feature) and location change conditions' reaction times get closer, location change condition's reaction time decays more than object change condition's reaction time in terms of amount of change, from one-change to three-change conditions.

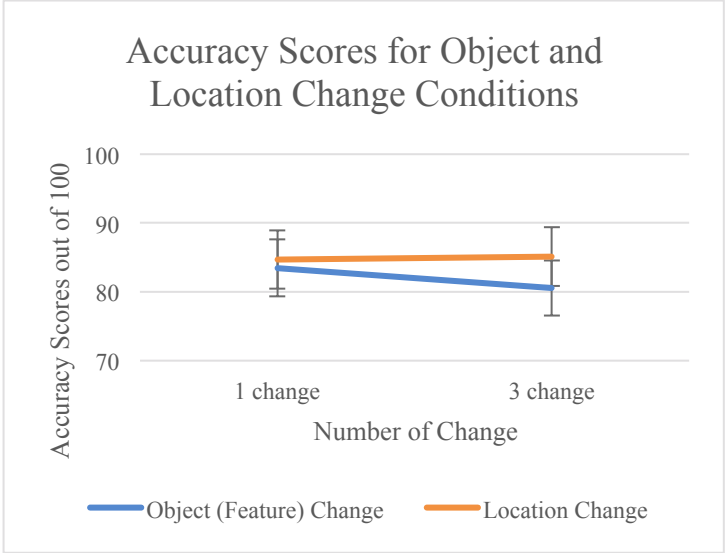

Figure 3. The graph shows the significant interaction effect of change types (object/feature and location conditions) and amount of change (one-change and three-change) on accuracy scores. The interaction indicates that with the decreasing of amount of change, object (feature) and location change conditions' accuracy rates get closer.

In congruency with the second hypothesis, as the amount of change increased (from one-change to three change), it took less time for participants to detect the changes. These findings indicate that, there is an interaction effect between reaction time and change variables. Number of change affected how fast the participants reacted in location and object change conditions. In other words, when the number of changes increases from one to three, reaction time gets faster and this pattern can be seen clearly in location change conditions rather than object change conditions. These results did not confirm the hypothesis about object changes taking longer time to detect. One object change condition had longer RTs, but detection in location change condition required more time. Such consequence could be attributed to some limitations of the present study, like image arrays. Image arrays did not contain image at the center, and this could create difficulty in attending to the presented array, because objects at the center and even fixation display grab attention. Therefore, the centrality makes easier for individuals to detect change (Austen & Enns, 2000). In addition, Kreitz et al (2015) mentioned centrality factors were attributed to WM and attentional breadth. In the present study, there was no object to be presented in the center and it is hard to attribute results to working memory capacity directly. However, it is possible to attribute location change results to spatial attention breadth, because items were given at the peripheral areas rather than the center. In addition, as the third hypothesis predicted, participants detected the change more accurately when the change was location based. Elmore and colleagues (2013) studied change blindness and tested the effects of location and object change in a change detection task. The present study's results replicated the findings of Elmore's study (2013), which revealed that accuracy rates were higher in location change than object change conditions. Contrary to what the

fourth hypothesis predicted participants detected the change more accurately as the amount of change decreased. Interaction effect was observed between accuracy and other dependent variables as well. Altering the amount of change interacts with the accuracy scores for both location and object change conditions. Decrease in the amount of change (from three to one) results with an increase in the accuracy scores in object change condition and with a slight decrease in the accuracy scores for location change condition.

d' values indicated insignificant results and it showed that participants did not differ across conditions in their sensitivity. However, in one-location change condition, d' was higher than the other conditions, which indicates that participants' sensitivity to this condition is relatively higher. Although the group differences between conditions were not significant, this enhanced sensitivity might be attributed to the visibility of the change, which will be discussed in the limitation part. On the other hand, these results might be depend on task related factors which hinder measuring d' prime. As an alternative perspective, results can be explained on diversity of tasks (Vermeiren & Cleeremans, 2012). The diversity is about being aware or unaware of the tasks (in this case, it is knowing or not knowing the change will occur) as a participant. In the Vermeiren and Cleeremans' study (2012), conditions were manipulated by changing tasks itself with respect to whether subjects are aware of the manipulation or not. In the present study, the participants were warned about the change, and they expected it. We used only subject-aware manipulations leading participants to direct their attention towards change. Consequently, we could not reach any significant result regarding sensitivity.

Inter-scale correlations were significant and consistent with our expectations. The hypothesis was that participants who were low in accuracy and fast in reaction time (due to trade-off between speed and accuracy), would experience cognitive failures in their daily lives. Additionally, they would be less sure about their answers in the change detection task. All of the correlations between daily life cognitive failures (through CFQ), sureness (reliance on the answers that are given in the experiment), and the scores which were obtained in the experiment should be examined. Negative correlation between CFQ and sureness scores are expected, because sureness scale was showing the confidence of the decisions and CFQ scale (unless it is reverse coded) was an indicator of real life setting sureness, relying on the decisions and memory. However, CFQ and sureness scores did not significantly correlate with both accuracy and reaction time scores. Which means that inter-scale relationship that measures daily life cognitive failures and participants' reliance on their given answers is congruent, people who experience less failure in their daily life also tend to be surer about their decisions. However, in the present experimental settings that was not the case. Accuracy scores and reaction time scores indicated insignificant relationship between scales. The first inference can be directed to individuals' own reflections about their self-confidence. Participants indicated their own subjective evaluations about their cognitive capabilities. Even if they recall their experiences to fill the questionnaires, the answers are not independent from their own thought process of self-image perceptions. The second inference can be deduced from the scale-experiment congruency. In the CFQ scale, the items were mostly consisted from cognitive failures due to memory, recall and recognition errors. However, the present experiment was focusing on change detection and attention rather than memorial processes. Therefore, the insignificant results can be attributed to the incongruity between experimental settings and measurement tools.

In general, both the location and object change had an effect on change detection paradigm. The study implied that location change is detected more accurately but slowly than detecting the object change. Additionally, detecting object change was faster but less accurate than detecting location change. Low amount of change is associated with longer reaction times but with more accurate results.

Limitations and Future Directions

Set size. In the present study set size was fixed to six. Participants were asked to guide their attention to the changing features, and it is unlikely to achieve the equivalent performance when the other salient features compete for attentional

resources (Boyer, Smith, Yu, & Bertenthal, 2011). Manipulation of the set size may alter the change detection rates according to the previous studies with the trend of increasing set size and decreasing detection rates (Hannon & Richards, 2010; Mitroff, Simons, & Levin, 2004; Guseva & Mikhaylovaa, 2013). Thus, manipulation of set size could elicit different results. For future direction, later studies could replicate the present study by manipulating memory set size and adding them with picture at center, which could lead to more fruitful results.

Array design. In the present study all of the arrays were consisted of fixed sets which are not altered according to their order of being central or peripheral within an intended manipulation. They were all around the center in the pre-change trial, and only in location change conditions the images could be in the center which is not measured via analysis. Furthermore, a study that correlated working memory capacity and spatial breadth of the attention, revealed a slightly decaying trend with change blindness in peripheral visual field without the main effect of WM capacity on change detection (Kreitz, Furley, Memmert, & Simons, 2015). Some studies indicated that putting a stimulus on the center or on the periphery, even being symmetric makes a difference in change detection, asymmetric settings make the change detection harder due to unclear structure of the visual field (Guseva & Mikhaylovaa, 2013). Additionally, in location change condition, with many violations of change (in terms of going center, periphery, or just shifting a little) there was no standardization of the arrays. Also, not shifting the arrays after the pair ends and fixation point appears, may influence the forthcoming arrays' visual representations, and leave some impressions even if there is a mask or in the present experiment, fixation. (Mitroff, Simons, & Levin, 2004).

Visual material. The pictures in the arrays were collected from various internet sources that can be easily differentiated from each other in terms of color, luminance, size, and width which make the detection easier. The difference of the pictures made the array pairs more prone to change detection without the experiment's intention. Also detecting color change requires more time than object (onset-offset) or location changes (Guseva & Mikhaylovaa, 2013). When there is an effect of color, as Guseva and Mikhaylovaa (2013) have mentioned, this may be a confounding variable.

Preserved representations. Several studies showed that change detection is not merely related to the recognition of the alterations (Favelle Palmisano, 2015; Mitroff, Simons Levin, 2004; Simons, Chabrisa, Schnura, & Levin, 2002). There are pre and post change allocated representations of the objects in the brain and sometimes change is actually detected unconsciously even if it is not reported as detected. In other words, change may go undetected even if they are detected in fact (Mitroff, Simons, & Levin, 2004; Simons et. al, 2002). In the present study, there is no measurement for pre and post-change representations rather than the mere detection of the change. Previous study of Mitroff and collegues (2004), which included 2AFC questions that were measuring the change detection, indicated remarkable results about implicit detection of change which are not reported explicitly during the change task. The practical value of the implicit change detection can be discussed in terms of not indicating correct results explicitly.

Masking. In the present study, there was no distraction between pre and post change arrays, therefore a chance for control of the influences of masking and ISI (interstimulus interval) are missing. In Pashler's study (1988) a main effect of masking is clearly shown. Furthermore, in terms of methodological concerns, timing of priming and time interval for change detection is an important factor to investigate. According to the change detection literature, when there is no mask and the inter-stimulus interval (ISI) was at the 34 milliseconds, and during the increment of interval (from 100 to 500 milliseconds), there was a positive increment in sensitivity of participants (Pashler, 1988).

Item Relations. The items on the arrays were randomly distributed according to their source associations. Therefore, in a single array, most of the objects were coming from various contexts. However, some of the contexts of figures were overlapping (such as two items from the same context in one array), The previous findings

demonstrate that configural (or array, in the present experiment) congruency slows down the change detection performance (Conci & Müller, 2014; LaPointe & Lupianez & Milliken, 2013).

Further implication that comes out with this study, might focus on standardization of the measures that can be used (set size, masking, central-peripheral localization etc.). The interaction between accuracy, reaction time, amount of change and change type may reveal some confounding variables that are used in the current experiments. Moreover, the implications can be used with working memory studies to examine change detection performance under different conditions. Eye-tracking methods can be adapted to this study to find out more accurate reasons in saccades, in terms of location change and object change. It would be useful to understand what visual attention's determinants are for detecting the changes in surrounding stimuli. In addition to the working memory capacity approach, implicit change detection may be studied in a more detailed way.

Conclusion

The purpose of the present study was to investigate change detection paradigm through manipulating the amount and the type of change. Results revealed that individuals performed faster when the object itself was changed rather than its location. Whereas, accuracy scores of location change condition were greater than the scores of object change condition. Interestingly, an increase in the amount of change leads to faster reaction time results, and lower accuracy rates. This trade-off is important for explaining attentional tendencies in change detection due to type and number of change, which have an impact on accuracy and response times. Therefore, the notable point which is the trade-off between accuracy and reaction time scores could be open to investigation for further research.

References

Austen, E., & Enns, J. T. (2000). Change detection: paying attention to detail. *Psyche, 6(11).* Beanland, V., & Chan, E. H. (2016). The relationship between sustained inattentional blindness and working memory capacity. *Attention, Perception & Psychophysics, 78*(3), 808-817.

Becker, M. W., & Rasmussen, I. P. (2008). Guidance of attention to objects and locations by long-term memory of natural scenes. *Journal of Experimental Psychology: Learning, Memory and Cognition, 34(6),* 1325-1338.

Berger, A., Henik, A., & Rafal, R. (2005). Competition between endogenous and exogenous orienting of visual attention. *Journal of Experimental Psychology: General*, *134*(2), 207.

Boyer, T. W., Smith, T. G., Yu, C., & Bertenthal, B. I. (2011). Visual Attention and Change Detection. *Proceedings of the 33rd Annual Conference of the Cognitive Science Society*, (pp. 1735-1740). Boston, Massachusetts.

Bredemeier, K., & Simons, D. J. (2012). Working memory and inattentional blindness. *Psychonomic Bulletin & Review, 19*, 239-244.

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British journal of clinical psychology*, *21*(1), 1-16.

Cole, G. G., Kentridge, R. W., Gellatly, A. R., & Heywood, C. A. (2003). Detectability of onsets versus offsets in the change detection paradigm. *Journal of Vision January, 3*(1), 22-31.

Conci, M., & Müller, H. J. (2014). Global scene layout modulates contextual learning in change detection. *Frontiers in Psychology*, *5*, 89. http://doi.org/10.3389/fpsyg.2014.00089

Ekici, G., Uysal, S. A., & Altuntaş, O. (2016). The validity and reliability of Cognitive failures questionnaire in university students. *Türk Fizyoterapi ve Rehabilitasyon Dergisi*, *27*(2), 55-60.

Elmore, L. C., Passaro, A., & Wright, A. A. (2013). Change detection for the study of object and location memory. *Behavioral Processes, 93*, 25-30.

Favelle, S. K., & Palmisano, S. (2015). Change magnitude does not guide attention in an object change detection task. *Perception, 44*(1), 93-99.

Fecteau, J. H., & Munoz, D. P. (2006). Salience, relevance, and firing: a priority map for target selection. *TRENDS in Cognitive Sciences, 10*(8), 382-390. doi:10.1016/j.tics.2006.06.011

Fockert, J. W., & Bremner, A. J. (2011). Release of inattentional blindness by high working memory load: Elucidating the relationship between working memory and selective attention. (400-408, Dü.) *Cognition, 121*.

Glass, B. D., Maddox, W. T., & Love, B. C. (2013). Real-time strategy game training: emergence of a cognitive flexibility trait. *PLoS One*, *8*(8), e70350.

Guseva, A., & Mikhaylovaa, O. (2013). Effects of Stimulus Parameters and Types of Changes in Change Blindness Task. *Social and Behavioral Sciences, 86*, 598-602.

Hannon, E. M., & Richards, A. (2010). Is inattentional blindness related to individual differences in visual working memory capacity or executive control functioning? *Perception, 39*, 309-319.

Koivisto, M., & Revonsuo, A. (2009). The effects of perceptual load on semantic processing under inattention. *Psychonomic Bulletin & Review, 16*(5), 864-868.

Kreitz, C., Furley, P., Memmert, D., & Simons, D. J. (2015). Inattentional Blindness and Individual Differences in Cognitive Abilities. *PLoS ONE, 10*(8).

LaPointe, M. R., Lupianez, J., & Milliken, B. (2013). Context congruency effects in change detection: Opposing effects on detection and identification. *Visual Cognition*, *21*(1), 99-122.

Ludwig, C. J., & Gilchrist, I. D. (2002). Stimulus-driven and goal-driven control over visual selection. *Journal of Experimental*

Psychology: human perception and performance, *28*(4), 902.

Mack, A. (2003). Inattentional blindness: looking without seeing. *Blackwell Publishing Inc, 12(5),* 180-184.

Mitroff, S. R., Simons, D. J., & Levin, D. T. (2004). Nothing compares 2 views: Change blindness can occur despite preserved access to the changed information. *Perception and Psychophysics, 66*(8), 1268-1281.

Park, G. D., & Reed, C. L. (2014). Nonuniform changes in the distribution of visual attention from visual complexity and action: A driving simulation study. *Perception, 43*(2), 129-144.

Pashler, H. (1988). Familiarity and visual change detection. *Perception & Psychophysics, 44*(4), 369-378.

Peirce, J. W. (2007). PsychoPy—Psychophysics software in Python. *Journal of Neuroscience Methods*, 8-13.

Rensink, R. A. (2005). Change blindness. *In McGraw-Hill Yearbook of Science & Technology*. 44-46.

Scholl, B. J. (2000). Attenuated change blindness for exogenously attended items in a flicker paradigm. *Visual Cognition*, *7*(1-3), 377-396.

Simons, D. J., & Ambinder, M. S. (2005). Change Blindness: Theory and Consequences. *Current Directions in Psycological Science, 14*(1), 44-48.

Simons, D. J., Chabrisa, C. F., Schnura, T., & Levin, D. T. (2002). Evidence for preserved representations in change blindness. *Consciousness and Cognition, 11*, 78-97.

Smith, T. J., Lamont, P., & Henderson, J. M. (2012). The penny drops: Change blindness at fixation. *Perception, 41*, 489-492.

Stanislaw, H., & Todorov, N. (1999). Calculation ofsignal detection theory measures. *Behavior Research Methods, Instruments, & Computers, 33*(1), 137-149.

Şenkal, I., N. R., Bakar, E., Çandar, T., Ekinci, M. E., Bozoğlu, E. F., & Çeltikçioğlu, G. (2015). Psychometric specifications of the Turkish versions of Cognitive Failures Questionnaire (CFQ) and Subjective Memory Complaints Scale (SMC). *Current Psychiatry and Psychoneuropharmacology, 5*(1), 5-12.

Vermeiren, A., & Cleeremans, A. (2012). The validity of d′ measures. *PloS one*, *7*(2), e31595.

The Impact of Increasing Levels of Difficulty on the Generation Effect

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An important aspect of learning and memory is the ability to generate desired information verbally or mentally. The purpose of this study is to examine whether increasing levels of task difficulty while encoding information leads to enhanced memory of the material in the generation effect paradigm. A stem-completion task was utilized as the main experimental setup, and difficulty was modulated through the provision of more or less clue letters. Though the initial findings of the generation effect were successfully replicated, increasing levels of difficulty were not found to impact the generation effect significantly. We thus conclude that the generation effect is a byproduct of the sort of cognitive operations performed on relevant information rather than being a phenomenon specific to generation per se.

Keywords: Generation Effect, encoding, memory

Slamecka & Graf's seminal 1978 paper explores the generation effect, a phenomenon of memory in which participants tend to be more likely to recognize or recall words that they generate themselves than words they are told to read. In a series of five experiments, Slamecka & Graf found that the generation effect occurred in both cued and uncued recognition tasks, for both between- and within-subjects experimental conditions, and across differing encoding rules. From their findings, Slamecka & Graf hypothesized that generation requires more cognitive effort than reading, and that this additional effort increases the participants' ability to remember generated words. They proposed a cognitive explanation for the generation effect in which, within an associative network model of memory, generation activates the nodes in the network to a greater extent than just reading, and facilitates future access to those nodes during recognition or recall (Slamecka & Graf, 1978).

Cognitive effort has long been associated with another phenomenon known as the levels-of-processing effect (Ekuni et al., 2011). The levels-of-processing effect refers to how recall performance is a function of depth of cognitive processing, with deeper levels of processing resulting in stronger, longer-lasting memories of stimuli compared to shallow levels of processing (Craik & Lockhard, 1972).

In a subsequent study in 1979, Craik & Jacoby demonstrated, in a paradigm where subjects had to rate how close in size two objects were, that more 'difficult' decisions lead to greater subsequent recall of the objects in question in comparison to 'easier' decisions. The difficulty of the decision was based on how easy the two objects were to compare in size. For example, an elephant and a mouse would be very easy to distinguish in size, whereas a hamster and a mouse would be more difficult. Their results showed that participants' recall performance for object names decreased as the size difference became more obvious, and that recall of the names improved as the task became more difficult. Craik & Jacoby concluded
that this improvement was due to a difficult task requiring greater cognitive effort, which leads to a deeper level of processing that then leads to the improvement in memory recall (Craik & Jacoby, 1979).

Though Craik & Jacoby (1979) refer only to a task where difficulty is measured by the establishment of relational contrast (e.g. size

comparison), Bertsch et al. (2007) report that other studies have found the beneficial impact of encoding difficulty on recall and recognition to occur under differing conditions as well. Other conditions include type of encoding (i.e., rhyme vs. sentence completion; McFarland, Frey, & Rhodes, 1980) and other paradigms in which the difficulty of encoding does not necessarily entail comparative judgments.

The purpose of this study is to test whether increased levels of difficulty affect the generation effect. Based on the results from existing literature, we hypothesize that increasing difficulty during encoding will lead to words being processed on a deeper level, which will then lead to a subsequent improvement in recognition. Within our experimental paradigm, the difficulty of generation will be manipulated by presenting participants with a closely associated cue word alongside a target word which will be missing differing amounts of letters. Therefore, words generated with more missing letters are predicted to demonstrate a higher incidence of recognition compared to words that are merely read aloud or generated with fewer missing letters.

Method

Participants

There were 30 participants (M_{age} = 18.9 years, *SD* = 0.93; 57% female) recruited for this study. All participants were recruited from Pomona College through social media advertisements placed on the Pomona College students' Facebook page.

Materials

The experiment was conducted using a Qualtrics survey running on either a computer or mobile device. The first question on the survey asked for the participants' consent. If the participant chose not to consent, the survey ended immediately.

All of the word pairs used during the second portion of the experiment were generated using the "University of South Florida Free Association Norms" index (Nelson et al., 2004). The words were chosen based on their forward cue-to-target strength (FSG), a metric between 0 and 1.0 that measures the likelihood of generating a target word given some cue word (Nelson et al., 2004). In order to ensure that the probability of participants being unable to generate the target word was minimized, only word pairs that had FSG scores above 0.4 were chosen. In order to ensure that the word generation process was not automatic for our easy trials, only word pairs with an FSG below 0.8 were chosen. As such, the word pairs in the experiment were those that had FSG scores between 0.4 and 0.8.

The "University of South Florida Free Association Norms" index (2004) does not include any standards for practical applications. The researchers therefore selected the thresholds based on the intuition that the strength of the semantic connection should be an intermediate value, skewed towards higher FSG values as the interpretation of non-generated words within the current paradigm is entirely non-informative.

The Qualtrics survey was designed such that it skipped a word pair if the participant failed to yield a response within 10 seconds to a simple prompt that appeared below each word pair in the generation conditions. The prompt was a simple YES/NO question that asked participants whether or not they were able to generate a word during the trial.

Procedure

Our experiment used a within-subjects design with three conditions: Easy generation, difficult generation, and reading. A total of 60 cue word-target word trials were presented to each participant, with 20 trials per condition. The trials were counterbalanced among all participants, such that all 60 cue word-target word pairs were presented randomly but equally across all three conditions (i.e. Word pairs that were presented to one participant in the read condition were presented to another participant as an easy or difficult generation condition, and vice versa).

For both generation conditions, participants were presented with words with missing letters and were asked to perform a word fragment completion task. The difference in difficulty across the two generation conditions was determined by the number of letters provided to the participants during the task. The difficult condition as such had only two letters provided, whereas the easy condition had only two letters missing. For example, one of the word pairs presented was BREAD - BUTTER; which, in the difficult condition, was presented as

BREAD - B _ _ _ _ R, and in the easy condition was presented as BREAD - B_T_ER. In the read condition, participants were simply presented with the 'BREAD - BUTTER' word pair. At the beginning of the experiment, participants were instructed to remember as many of the target words as they could and told that they would have to remember them later in the experiment. Additionally, participants were instructed to read out the target word in each trial, regardless of whether they had to generate or read it. Reading the words out loud, assuming strict adherence to the task instructions by the participants, ensured that the target words in the read condition were all attended to (McElroy & Slamecka, 1982).

Following the word-pair study portion of the experiment, participants were asked to engage in a distractor task. This task involved participants listing as many of the U.S. states as possible from memory within one minute. Afterwards, participants were asked to perform an old versus new recognition task in which they were sequentially presented with 120 words, 60 of which were target words that they had either previously read or generated with 60 others being new words (words they had not been exposed to during the experiment).

In order to control for possible differences in recognition during the test phase caused by differing word lengths, only six-letter words were generated for both the 60 target words and 60 new words (Baddeley, 1975). As the cue words were not utilized in the recognition segment of the experiment, their lengths were not controlled for. The experimenters ensured that the new words did not appear as either target words or cue words during the initial portion of the experiment.

Results

The main measure of accuracy for this experiment was the accuracy of the responses given during the old and new word recognition task. If a participant recognized one of the words as a target word that had previously appeared in the experiment, and it indeed had appeared previously as a target word, the response would be considered a correct response.

This measure of accuracy was only applicable to words which the participant had either read or managed to generate in time. As such, 0.06% (110 out of 1800 total) of the recognition trials were excluded from the analysis of accuracy across all conditions, 80% of which occurred in the difficult generation condition. There were, however, no outliers in terms of an inability to generate words or inaccuracy during the recognition task which were excluded from the analysis. The accuracy for the responses given to the 'new' words was very high and showed little variation across subjects (M = 94.1, SD = 0.73).

The mean accuracy was found to be highest for the difficult generation condition (M = 85.3, SD = 8.89). Mean accuracy was comparatively lower for the easy generation condition (M = 80.6, SD = 8.66) and lowest for the read condition (M = 45.8, SD = 5.29) (Figure 1).

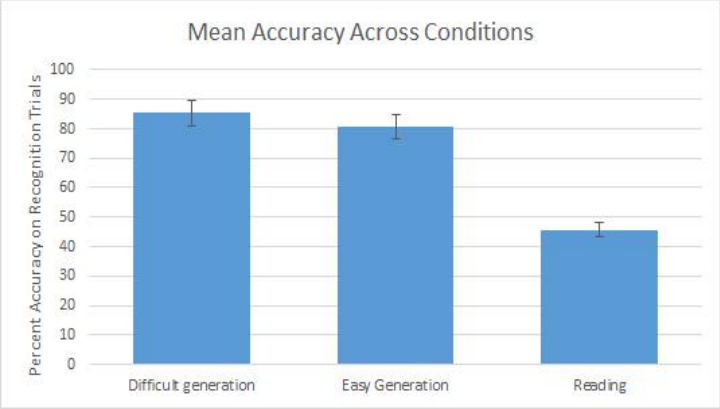

Figure 1. Comparison of mean accuracies across all three conditions.

A one-way between subjects ANOVA across the three means obtained per condition revealed a significant effect [$F(2,6) = 15.34$, $p < 0.01$)]. Planned pairwise comparisons revealed that recognition was significantly higher in the easy generation condition than the read condition [$t(3) = 4.85$, $p < 0.01$] and significantly higher in the difficult condition than the read condition [$t(3) = 5.39$, $p < 0.01$]; however, there was no significant difference between the easy and difficult generation conditions [$t(4) = 0.54$, $p = 0.31$].

Discussion

Our results did not support our hypothesis that increased levels of difficulty in generating words results in higher levels of recognition for the words involved in the more difficult task. Our experimental results replicated the robust findings in the generation effect literature on the difference

between self-generated and read words, but failed to demonstrate a significant difference between the recognition of self-generated words that were generated in a more or less difficult paradigm. Our results suggest that increased levels of difficulty do not have an effect on the subsequent recognition of self-generated words.

A possible interpretation of our findings is that the difference in cognitive effort between the self-generation condition and the reading conditions is significantly larger than the difference in cognitive effort that our critical manipulation (generation of fragmented words with less or more letters given) managed to elicit between the difficult and easy generation conditions. This interpretation suggests that a stronger manipulation in difficulty may be necessary to elicit a significant difference in recall performance between the easy and difficult generation conditions. One might consider the asymmetry in the failed generation trials between the easy (20% trials) and difficult (80% trials) conditions as providing evidence that such a manipulation may not be feasible. However, the low overall failed generation ratio in the difficult generation condition (15%) indicates that such pessimism is unwarranted: Increasing the difficulty of generation trials (perhaps through the utilization of word-pairs with lower average FSG values or through the provision of less 'clue' letters in the generation condition) may be worth exploring in future research.

Another interpretation would suggest that the significant effect observed in the literature on the generation effect might be caused by a difference in the levels of processing between the reading and generation conditions that is mediated by
the utilization of different cognitive mechanisms during reading and generation. Under this interpretation, increasing the level of difficulty of the generation condition might not lead to a difference in the level of processing (and as such a significant difference in subsequent recall) necessitated by the task, as the results of our experiment demonstrate. That is, the hypothesized extensive activation of the associative network that generation elicits in comparison to reading might not be sensitive to changes in the cognitive effort encountered during the generation task.

Methodological issues encountered during the experiment may also have influenced our results. As the survey was distributed and conducted online, we were not able to control for the environment in which the participant took the survey. Thus, there was a high probability that participants took the survey in environments where distractions may have caused for the results of our experiment to be influenced in unpredictable ways – these unidentifiable confounds could explain the noteworthy below-chance performance obtained for the 'read' condition, though further research would need to confirm the presence of this effect. The online environment also prevented the researchers from ensuring that the participants actually read aloud each word-pair. This necessarily implies that the researchers cannot verify that a critical procedural manipulation ensuring attentiveness was adhered to, which might have resulted in the 'read' condition results being lower than expected. Further experiments conducted in more controlled experimental environments might clarify the impact of these confounds on the results.

McNamarra (1992) concludes her informative overview of the current state of our understanding of the generation effect with the conclusion that these studies, many investigating differing cognitive models of the effect, all seem to converge on the finding that the superior retention associated with the generation effect is a consequence of the sort of 'cognitive operations' performed on the information. Though loosely defined in McNamarra's 1992 paper, 'cognitive operations' can be interpreted as the sort of task that accompanies the processing of word-pairs in our paradigm (i.e., reading or generation). This framing is in direct opposition to the one offered by Slamecka & Graf's (1978) initial conclusion that the generation effect is simply a by-product of the process of generation.

Bertsch et al.'s more recent (2007) meta-analysis also points to the presence of seemingly contradictory findings reported in the literature regarding the generation effect. The reframing offered by McNamarra (1992) helps us not only

account for the presence of these aforementioned contradictory findings, but also for our results. If the generation effect is truly dependent simply on the ‘cognitive operations’ performed on the information, then the switch from easy to difficult generation would not be expected to lead to improvements in future recall. Thus, our results can be viewed as evidence for this interpretation of the generation effect, which seems to be the only parsimonious account of the phenomenon remaining after decades of research.

References

Baddeley, A. D., Thomson, N., & Buchanan, M. (1975). Word length and the structure of short-term memory. *Journal of verbal learning and verbal behavior*, *14*(6), 575-589.

Bertsch, S., Pesta, B. J., Wiscott, R., & McDaniel, M. A. (2007). The generation effect: A meta-analytic review. *Memory & cognition*, *35*(2), 201-210.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of verbal learning and verbal behavior*, *11*(6), 671-684.

Ekuni, Roberta, Vaz, Leonardo José, & Bueno, Orlando Francisco Amodeo. (2011). Levels of processing: the evolution of a framework. *Psychology & Neuroscience*, *4*(3), 333.

McFarland, C. E., Frey, T. J., & Rhodes, D. D. (1980). Retrieval of internally versus externally generated words in episodic memory. *Journal of Verbal Learning and Verbal Behavior*, *19*(2), 210-225.

Jacoby, L. L., Craik, F. I., & Begg, I. (1979). Effects of decision difficulty on recognition and recall. *Journal of Verbal Learning and Verbal Behavior*, *18*(5), 585-600.

McNamara, D. S. (1992). *The Generation Effect: A Detailed Analysis of the Role of Semantic Processing* (No. 92-2). Technical Report.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods, Instruments, & Computers*, *36*(3), 402-407.

Slamecka, N. J., & Graf, P. (1978). The generation effect: delineation of a phenomenon. *Journal of experimental Psychology: Human learning and Memory*, *4*(6), 5

The review of five empirical studies: To what extent contemporary findings provide biological evidence for Eysenck's PEN Model?

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Eysenck's PEN theory has suggested an influential explanation for the biological basis of personality dimensions: Psychoticism, Extraversion and Neuroticism. In his model, he explained them by focusing on the level of brain activities, the functioning of autonomous nervous system and hormonal balances. Today, the development of technology enables the measurement of brain activities in relation to different functions and the investigation of those dimensions biologically. This review aims to discuss current scientific findings on personality dimensions using neuroimaging techniques, biological and self-report measurements and experimental designs. It further examines to what extent contemporary findings provide biological evidence for Eysenck's PEN Model. Findings indicated that extraversion is associated with an increased level of brain activity whereas neuroticism is associated with a reduction in the brain activity as Eysenck suggested. Furthermore, the link between testosterone levels and psychoticism was also investigated in females. Finally, it was concluded that these contemporary findings supported the key points of the PEN Model although their comparisons to opposite dimensions, their relationship with the autonomic nervous system and sex-related differences remain unclear. Thus, it might be interesting to study these points as a future direction and provide additional evidence for biological markers of personality dimensions.

Keywords**:** PEN Theory, Eysenck, Biological Basis

Hans Eysenck is a German psychologist who is known with his contributions to the development of behavioural therapy and clinical psychology during the post-war period (Rachman, 2003). The World War II affected people by creating an environment full of traumas, panic and fear which gave rise to various disorders such as war neuroses, post-traumatic stress disorder, behavioural disorders and mental deficiency (Grinker & Spiegel, 1945; Van der Kolk, 2003; Appel, Beebe and Hilger, 1946). Hence, there was a huge interest and need for psychiatric therapies as most people were suffering from depression and anxiety disorders such as agoraphobia (Rachman, 2003). Therefore, the meeting of Eysenck and Dr. Aubrey Lewis who was responsible for a research and clinical psychiatric facility during the war played a critical role in the development of Eysenck's academic career and specialization in the field. Eysenck (1991) brought new perspectives to clinical psychology by criticizing Freud's theory of psychoanalysis and developing behavioural therapies as a different approach to psychiatric disorders. In the early 1960s, the cognitive revolution took place and influenced various researchers including Eysenck. Later, in the mid-1980s, he developed cognitive behavioural therapies by incorporating the cognitive and biological aspects with the behavioural features of disorders. Thus, he developed PEN's model (Psychoticism, Extraversion, Neuroticism) based on his factor-analytic research.

Today, Eysenck's theory is one of the crucial milestones in the literature of personality theories. His theory influenced by cognitive revolution is based on personality dimensions that are explained through the nervous system including brain activity,

and hormones (Eysenck, 1983). Eysenck (1983) firstly, described two personality traits as extraversion vs. introversion and neuroticism vs. stability that played a crucial role in the formation of other outstanding personality theories such as the biopsychological theory of Jeffrey Grey and McCrae's version of the Big Five theory although the way they explain these dimensions differ from each other (Gray, 1970; McCrae & John, 1992). Nevertheless, it could be considered as influential especially for the McCrae's Big Five Theory as they converge in terms of factors and personality dimensions (Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993). Later, he revised his model by including psychoticism as a personality dimension.

The first dimension of the model, extraversion, refers to characteristics such as outgoingness, openness to experience, sociability and assertiveness whereas introversion is defined by inwardness and involvement in solitary activities (Friedman & Schustack, 2014). Extraversion is based on a low level of brain activities so that extrovert people seek for social interactions to achieve a certain level of brain activation through external stimulation. On the other hand, introversion appears as a result of already existing high levels of brain activities. Therefore, contrary to extrovert people, introverts do not need further stimulation from their environment and they are more likely to avoid social interactions because they are biologically already saturated in terms of activation.

The second dimension of the model suggests that neuroticism is defined by the instability in emotions and inability to control reactions against stressors, which is related to the activity of sympathetic nervous system responsible for fight or flight response (Friedman & Schustack, 2014; McLeod, 2017). In opposite, emotionally stable people manage stressors better, as compared to neurotic people, and they are better at controlling their feelings such as anger and fear.

Finally, the third dimension of the model asserts that psychoticism, characterized by abnormal behaviours, is another personality dimension connected to the levels of testosterone hormones and anti-social behaviours (Blackburn, 1975; Eysenck, 1967; Eysenck and Eysenck, 1975). Although the PEN model of Eysenck well defines biological aspects of personality traits, to what extent this theory is supported by biological evidence remains unclear. In this review, firstly, some contemporary findings are reported, later they are discussed in terms of their relationship with Eysenck's PEN model.

Current findings

Although studies on the relationship between neuroanatomical brain regions and their function are well established (Davidson & Irvin, 1999; Grossman et al., 2000; Tononi, Sporns & Edelman, 1994; Phan, Wager, Taylor & Liberzon, 2002), the link between brain activation and personality traits is still under investigation (Sampaio, Soares, Coutinho, Sousa & Gonçalves, 2014; Volkow et al., 2011; Wei et al., 2011). It seems crucial to determine the brain activities specific to personality traits because it would enable us to use these findings as "biological markers" of the personality as a stable reference independent from the environment (Sampaio et al., 2014). As such, Sampaio et al. (2014) investigated the relationship between Big Five personality traits and Default Mode Network's (DMN) activity patterns in the brain which refers to highly active cortical areas at resting state. The study was performed with 30 females and 19 males with the average age of 25 years by administering personality scales (NEO-FFI) first, then by conducting task-free fMRI scanning. Results indicated that extraversion was positively correlated with the midline core of DMN regions involved in self-referential processing. Specifically, it was positively correlated with right precuneus, bilateral superior parietal lobe and left inferior parietal lobe whereas neuroticism was negatively correlated with right superior parietal cortex. Regarding different activated brain regions, they concluded that as expected, there are significantly different activation patterns for different personality traits which are also observable for neuroticism and extraversion dimensions.

Similarly, Adelstein et al. (2011) aimed to find a stable link between Big five personality traits and the brain structure by focusing on the functional connections of seed locations in the anterior cingulate cortex (ACC) and precuneus (PCU). For this purpose, they measured the brain activity of 39

subjects (18 males and 21 females with the average age of 30 years) at rest through fMRI without giving any specific task, and they compared activated brain regions with regions of interests. For behavioural comparison, participants were administered a questionnaire measuring personality traits. It was concluded that there was a differential pattern of functional connectivity specific to different personality traits. Specifically, neuroticism predicted the connection of seed regions with dorsomedial prefrontal cortex whereas extraversion predicted the connection of seed regions with lateral paralimbic regions.

Differently from these studies, Drabant et al. (2011) used both an experimental design and a neuroimaging technique. In their study, neuroticism was examined from a comprehensive perspective by investigating its role on the anticipatory anxiety that emerges as a response to the unpredictability of an aversive or threatening stimulus. Therefore, the relationship between the anticipation of aversive stimuli and eventually generated responses such as anxiety experience, autonomic response and neural activity were investigated while testing neuroticism as a moderator. Concerning this issue, they used electrical shocks as aversive stimuli with unpredictable intensity, time and event to create anticipatory anxiety (Drabant et al., 2011). In the first study, 95 healthy females with the average age of 21.8 were recruited and during the experiment, their autonomic responses to shock anticipation were measured. In the second study, 51 healthy females with the average age of 22.2 were recruited, and during shock anticipation, their neural brain activities were measured through fMRI. Neuroticism of all participants was assessed with a self-report neuroticism scale. Both studies indicated that anxiety levels, electrodermal responses and brain activities increase as the intensity of shock increases. In addition, in study 1, high neuroticism was associated with higher levels of anxiety compared to low neuroticism although this effect was not observed in study 2. However, study 2 underlined that neuroticism was negatively correlated with brain activity especially in regions involved in perception, integration and interpretation. Therefore, it was concluded that neuroticism influenced anticipatory effects on anxiety experience and brain activation.

In addition to extraversion and neuroticism, there are also neuroscience studies conducted on psychoticism from biological aspects. Tajima-Pozo, Bayón, Díaz-Marsá & Carrasco (2015) investigated the relationship between Testosterone (T) levels and different personality traits such as impulsivity and sensation seeking in a group of healthy individuals. In their study, 34 females and 20 male participants between 20 and 43 years were randomly selected from institutions. Subjects with any mental disorder or substance abuse were eliminated from the study through psychiatric interviews (Tajima-Pozo et al., 2015). Participants were drawn a blood sample for the measurement of the basal plasma T levels at rest, and after 24 hours, they completed six questionnaires measuring impulsivity, sensation seeking, anxiety, mood disturbance and personality dimensions such as psychoticism according to Eysenck's dimensional model. For both genders, high levels of T were positively and significantly correlated with anti-social behaviour, criminal and compulsive traits. On the other hand, they were negatively and significantly correlated with neuroticism and impulsivity. In addition, a significant positive correlation was observed between T levels of females and psychoticism whereas T levels of males were significantly and positively associated with drug abuse, hypomania and anti-social behaviour. Therefore, it was concluded that T levels were associated with anti-social behaviours and some personality traits depending on sex; however, an association between aggression and T levels could not be confirmed contrary to previous findings existing in the literature.

Furthermore, Kumari and colleagues (2008) studied psychoticism by focusing on PPI (prepulse inhibition) which is a term used for a response to an initial stimulation that causes an inhibition effect on the second response to a stronger stimulation (Geyer, Swerdlow, Mansbach & Braff, 1990; Graham, 1975). In their study, Kumari, Antonova & Geyer (2008) performed a fMRI study on 14 healthy men with average age of 37 years to relate psychosis-proneness with PPI and activation of PPI

related regions (thalamus, striatum and frontal regions). For this purpose, a prepulse inhibition experiment was performed by using an air-puff delivery system triggering the eye-blink reflex response. The experiment was designed with 4 different conditions: pulse alone, prepulse alone, 30s and 120s stimulus onset asynchrony and presented five times in 30-s blocks in pseudo-random order to each participant. Simultaneously, EMG activity of subjects was recorded (Kumari et al., 2008). Finally, psychosis proneness was measured through psychoticism scale (EPQ-R). The findings indicated that high psychosis in healthy individuals was significantly associated with lower tactile PPI and was significantly and negatively correlated with PPI related brain regions.

Discussion

According to the findings in the last decade, it could be deduced that there are functional and structural differences in activated brain regions specific to personality traits which provide a biological evidence for PEN's model. For instance, extraversion was found to be associated with the activation of brain regions involved in predicting others' actions, attention, visuospatial perception, emotion and self-referential processing (Adelstein et al., 2011; van Elk, 2014; Johns, 2014; Sampaio et al., 2014). These functional findings are reasonable because as an extravert person seeks for external stimulation, we expect to observe high attentional and perception processes toward others. From this perspective, it supports the definition of extraversion suggested by Eysenck. However, neither of these studies made comparisons between cortical activities of extraverts and introverts. Therefore, it remains unclear whether introverts show higher brain activities compared to extraverts.

Neuroticism, on the other hand, was associated with the reduction of neural activity in brain regions such as the right parietal cortex, which is crucial especially for perception, integration and information interpretation (Drabant et al., 2011; Kanai, Carmel, Bahrami, Rees, 2011; Sampaio et al., 2014). This finding is reasonable because the threshold of neurotic people for cortical activation might be lower than the standard threshold as Eysenck (1983) suggested. Regarding this issue, neurotic people might become more susceptible to environmental cues which probably causes the over-activation of the sympathetic nervous system. Consistently, high neuroticism resulted in higher anxiety compared to low neuroticism which indicated that there is low control over emotions leading to sensitivity to stress and emotional instability as it was defined in Eysenck's model (Drabant et al., 2011; Friedman & Schustack, 2014). Although those findings were not directly explained through the functioning of the autonomous nervous system, it is possible to consider them an indirect evidence for the abnormal activity of the sympathetic nervous system. In other words, if we consider findings showing the reduced activation in brain regions that are involved in perception processes of neurotic people, it could be also asserted that their sympathetic nervous system is impaired and that they cannot control their automatic emotional responses. The main reason for this interpretation is that their network was found to be associated with dorsomedial prefrontal cortex (Adelstein et al., 2011) which is responsible for conscious thinking and repressing emotions by working in an antagonist manner with the amygdala (Goldin, McRae, Ramel & Gross, 2008). For that reason, it could be argued that in case of neuroticism, the sympathetic nervous system is excessively alarmed; therefore, fight and flight responses are generated by leading to feelings of anxiety. Further, it could be hypothesized that the prefrontal cortex may fail to take under control those excessive fight and flight responses and high levels of anxiety. From that perspective, the reduced neural activation in cortical areas in neuroticism might be associated with the reduced activation of prefrontal cortex and therefore with the breakdown in perception processes and emotion regulatory pathways. Thus, it might be interesting to further investigate the relationship between the neural activity of prefrontal cortex and amygdala in neuroticism to examine whether there is a significant difference in the functioning of perception processes and emotion regulatory processes.

Finally, testosterone levels were positively and significantly associated with antisocial behaviour in both males and females (Tajima-Pozo

et al., 2015). However, a positive and significant association between testosterone levels and psychoticism was observed only in females (Tajima-Pozo et al., 2015). Different hormonal balances depending on sex could explain this difference observed between females and males. Therefore, while interpreting this finding, it might be interesting to take into consideration the optimum testosterone levels required for males and females. Hence, it is understandable that the relationship between testosterone levels and psychoticism differ depending on the biology of different sexes. In other words, males may tolerate testosterone levels more than females, and that might explain why Tajima-Pozo and his colleagues (2015) failed to find a significantly positive relationship between testosterone levels and psychoticism in males. Moreover, it is quite crucial to question the gender norms and the way the trait of interest is exhibited by females and males, as they may differ due to real biological differences and gender roles. When viewed from this aspect, the scale used to measure psychoticism may not be sensitive enough for detecting psychoticism in males. Interestingly, Tajima-Pozo et al. (2015) could not confirm the association between aggression and psychoticism which interferes with Eysenck's definition for psychoticism (Rushton, Fulker, Neale, Nias, & Eysenck, 1989) and the findings of Kumari and his colleagues (2008). In their study, Kumari et al. (2008) indicated that psychoticism was associated with lower prepulse inhibition. Hence, it could be expected that psychotic individuals fail to inhibit their anger and frustration which may provoke the exhibition of aggressive and impulsive behaviours. A possible explanation for the finding of Tajima-Pozo et al. (2015) may be the use of self-report measures of impulsivity and aggression that may induce social desirability in participants and influence the results. Thereby, it may be very informative if the link between aggression and psychoticism is examined in the future with different methodologies. Therefore, both in neurological and hormonal levels, these findings support the PEN model to a certain extent, but the difference observed between sexes and the relationship between aggression and psychoticism still remain unclear. For that reason, it may be interesting to replicate the study of Tajima-Pozo and colleagues (2015) with psychotic males and females by considering different hormonal balances and revising the sensitivity of scales of impulsivity and psychoticism to assure that false negative responses are avoided.

Consistent with the Eysenck's PEN model, findings that were discussed in this review indicated that extraversion was significantly associated with increased brain activity, whereas neuroticism was significantly associated with reduced brain activity (Sampaio et al., 2014; Adelstein et al., 2011; Drabant et al., 2011). Psychoticism was significantly associated with lower prepulse inhibition (Kumari et al., 2008). As Eysenck (1975) suggested, psychoticism was associated with testosterone levels, however, this association was observable only for females (Tajima-Pozo et al., 2015). Considering all these findings, it could be deduced that the results of these studies converge with Eysenck's PEN Model and provide important biological evidence for his suggestions. Nevertheless, future research should focus on the association between aggression and psychoticism, the functioning of the sympathetic nervous system and prefrontal cortex in neuroticism, and finally, the examination of introversion and stability. Especially studies on introversion and stability can be a future research direction because although those traits are under investigation, there is a lack of research comparing opposite traits (extraversion vs. introversion and psychoticism vs. stability) with each other in terms of neuronal activity. Beyond the biological understanding of personality, these investigations may contribute to the field of developmental psychopathology by enabling to compare typical and atypical brain functioning and their interaction with individual differences in neuronal level. It may also help to understand the etiology of psychopathologies because biological evidence for personality traits may act as biomarkers in the future.

References

Adelstein, J. S., Shehzad, Z., Mennes, M., DeYoung, C. G., Zuo, X. N., Kelly, C., ... & Milham, M. P. (2011). Personality is reflected in the brain's intrinsic functional architecture. *PloS one*, *6*(11), e27633

Appel, J. W., Beebe, G. W., & Hilger, D. W. (1946). Comparative incidence of neuropsychiatric casualties in World War I and World War II. *American journal of Psychiatry*, *103*(2), 196-199.

Blackburn, R. (1975). An empirical classification of psychopathic personality. *The British Journal of Psychiatry*, *127*(5), 456-460.

Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in cognitive sciences*, *3*(1), 11-21.

Drabant, E. M., Kuo, J. R., Ramel, W., Blechert, J., Edge, M. D., Cooper, J. R., ... & Gross, J. J. (2011). Experiential, autonomic, and neural responses during threat anticipation vary as a function of threat intensity and neuroticism. *Neuroimage*, *55*(1), 401-410.

Eysenck, H. J. (1967). *The biological basis of personality* (Vol. 689). Transaction publishers.

Eysenck, H. J., & Eysenck, S. B. G. (1975). *Manual of the Eysenck Personality Questionnaire (junior and adult)*. Hodder and Stoughton.

Eysenck, H. J. (1983). Psychophysiology and personality: Extraversion, neuroticism and psychoticism. In *Individual Differences and Psychopathology*.13-30.

Eysenck, H. J. (1991). *Decline and fall of the Freudian empire*. Transaction Publishers.

Friedman, H. S., & Schustack, M. W. (2014). *Personality: Classic theories and modern research*. Pearson.

Geyer, M. A., Swerdlow, N. R., Mansbach, R. S., & Braff, D. L. (1990). Startle response models of sensorimotor gating and habituation deficits in schizophrenia. *Brain research bulletin*, *25*(3), 485-498.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: reappraisal and suppression of negative emotion. *Biological psychiatry*, *63*(6), 577-586.

Graham, F. K. (1975). The more or less startling effects of weak prestimulation. *Psychophysiology*, *12*(3), 238-248.

Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behaviour research and therapy*, *8*(3), 249-266.

Grinker, R. R., & Spiegel, J. P. (1945). War neuroses. Oxford, England: Blakiston.

Grossman, E., Donnelly, M., Price, R., Pickens, D., Morgan, V., Neighbor, G., & Blake, R. (2000). Brain areas involved in perception of biological motion. *Journal of cognitive neuroscience*, *12*(5), 711-720.

Johns, P. (2014). Functional neuroanatomy. *Clinical Neuroscience*, 27-47.

Kanai, R., Carmel, D., Bahrami, B., & Rees, G. (2011). Structural and functional fractionation of right superior parietal cortex in bistable perception. *Current biology*, *21*(3), R106-R107.

Kumari, V., Antonova, E., & Geyer, M. A. (2008). Prepulse inhibition and "psychosis-proneness" in healthy individuals: an fMRI study. *European Psychiatry*, *23*(4), 274-280.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of personality*, *60*(2), 175-215.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: a meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage*, *16*(2), 331-348.

Rachman, J. (2003). Eysenck and the development of CBT. *The Psychologist*, *16*(11), 588-591.

Rushton, J. P., Fulker, D. W., Neale, M. C., Nias, D. K., & Eysenck, H. J. (1989). Ageing and the relation of aggression, altruism and assertiveness scales to the Eysenck Personality Questionnaire. *Personality and individual differences*, *10*(2), 261-263.

Sampaio, A., Soares, J. M., Coutinho, J., Sousa, N., & Gonçalves, Ó. F. (2014). The Big Five default brain: functional evidence. *Brain Structure and Function*, *219*(6), 1913-1922.

Tajima-Pozo, K., Bayón, C., Díaz-Marsá, M., & Carrasco, J. L. (2015). Correlation between personality traits and testosterone concentrations in healthy population. *Indian journal of psychological medicine*, *37*(3), 317-321.

Tononi, G., Sporns, O., & Edelman, G. M. (1994). A measure for brain complexity: relating functional segregation and integration in the nervous system. *Proceedings of the National Academy of Sciences*, *91*(11), 5033-5037.

Van der Kolk, B. A. (2003). *Psychological trauma.* American Psychiatric Pub. 159-161.

van Elk, M. (2014). The left inferior parietal lobe represents stored hand-postures for object use and action prediction. *Frontiers in psychology*, *5*, 333.

Volkow, N. D., Tomasi, D., Wang, G. J., Fowler, J. S., Telang, F., Goldstein, R. Z., ... & Millard, J. (2011). Positive emotionality is associated with baseline metabolism in orbitofrontal cortex and in regions of the default network. *Molecular psychiatry*, *16*(8), 818-825.

Wei, L., Duan, X., Yang, Y., Liao, W., Gao, Q., Ding, J. R., ... & Chen, H. (2011). The synchronization of spontaneous BOLD activity predicts extraversion and neuroticism. *Brain research*, *1419*, 68-75.

Zuckerman, M., Kuhlman, D. M., Joireman, J., Teta, P., & Kraft, M. (1993). A comparison of three structural models for personality: The Big Three, the Big Five, and the Alternative Five. *Journal of personality and social psychology*, *65*(4), 757-768.

The Commonalities and Differences of Alzheimer's Disease and Frontotemporal Dementia in Artistic Creativity

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Although patients with neurodegenerative disorders that operate on PFC display deteriorated cognitive skills that have adverse impacts on their life, in some clinical cases, unprecedented increase in artistic creativity is observed. These case studies are in conflict with both the theoretical role of PFC regions on creative thinking and neuroimaging data that support PFC's theoretical conceptualization. Yet, dementia is an umbrella term that encompasses many variants, such as Alzheimer's Disease (AD) and Frontotemporal Dementia (FTD). Accordingly, this review paper compares and contrasts the patients suffering from AD or FTD and reveal the commonalities and differences between them to explore how artistic creativity alters with the prognosis of dementia. The review of clinical observations revealed that although patients with both disorders displayed increased levels of abstraction and release from normative constraints, the augmentation in the creativity of these patients cannot be generalized to other patients as well and is subject to combination of many idiosyncratic factors. For instance, an alternative explanation for artistic proliferation is that the obsession for practicing the ritualistic behavior and emancipation from norms are the main reason for such clinical cases to occur. It is important to note that why a discrepancy between neuroimaging data and case studies at hand is that the way neuroscientific approach defines creativity is different than point of views that promote unconventional expression in artistic products.

Keywords: Alzheimer's Disease, Frontotemporal Dementia, Creativity

What Defines Creativity?

The creativity of human intellect had been attempted to be defined from different perspectives through tapping on various indicators. For instance, the neuroscientific point of view defines creativity as the faculty of producing a work, which is original and valuable by its very nature. On the other hand, evolutionary approach describes it as a capacity of adapting the novel environments and a problem-solving skill in terms of overreaching prevalent ideas and develop alternative behaviors (de Souza et al., 2014). Whatever approach is used to define creativity; the unique neurological organization of the brain, the devoted cognition to it, biological remnants of innovative thinking as well as bio-cultural practices are echoed (Zaidel, 2014).

The Role of Prefrontal Cortex (PFC) In Creativity

As Changeux (2005) mentioned, creativity depends on fundamental cognitive processes; including working memory, attention, abstract thinking etc. all of them which rely heavily on the prefrontal cortex (de Souza et al., 2014). Furthermore, the intense and reciprocal connections between PFC and other brain regions (Mesulam, 1998) allow PFC to act as a hub, which integrates information coming from multiple sources and projects the mental representations of the internal-external world (Nee et al., 2013); thereby supporting complicated abilities, such as creativity (Changeux, 2005). A meta-analysis conducted by Gönen-Yaacovi and her colleagues (2013) is in line with the aforementioned cognitive theories: They have reviewed the articles that had attempted to investigate the neural basis of creative thinking through neuroimaging techniques (operationalized

by different tasks, e.g., divergent thinking) and identified common set of brain locations, including multiple subregions of PFC as well as the regions that have vital involvement in semantic memory such as temporo-parietal region, posterior temporal and antero-lateral temporal cortex. Furthermore, they explored that dissimilar cognitive processes are backed by distinct prefrontal subregions.

Art, in this sense, is a unique manifestation of the humanistic creativity. It is mainly a symbolic communicative system that transmit norms, ideas, history, principles, morals etc. (Zaidel, 2014). As Miller & Miller (2013) point out, the primary assumption of behavioral neurology is that no matter how complex a behavior is, it is possible to constitute the model of that complex behavior by shedding light onto the smaller cognitive functions. In turn, this promotes the desire to investigate the relationship between creativity, brain and art; thus, creating opportunity to gain insight into overall creativity through exploring the underlying principles of artistic creation (Zaidel, 2014).

The cognitive theories and neuroimaging data appreciate the integrity and significance of PFC in creative thinking. Not surprisingly, neurological diseases operating on PFC impair the creative processes (Rankin et al., 2007). Yet, series of clinical observations and corresponding case studies revealed a distinctive pattern: exacerbation of artistic abilities of patients with neurodegenerative diseases impairing PFC (de Souza et al., 2014. This paradoxical finding of enhanced creativity in frontal diseases and more specifically, patients developing artistic abilities challenge both the theoretical role of PFC during creative thinking and neuroimaging findings. The emergence of *de novo* (becoming artist after the damage) cases may highlight the fact that the symbolic and referential communication system can compensate for the absence of regular linguistic communication capabilities, due to massive flexibility of the brain (de Souza et al., 2014). By doing so, artistic skills of the patients, such as painting and drawing allow the expansion of interaction channels. Ostensibly, as de Souza et al. (2010) note, art does not seem to be as susceptible to brain damages as language.

More interestingly, de Souza and his colleagues (2010) conducted patient studies to reveal the importance of PFC regions in critical thinking. Unlike the clinical observations that detected facilitated creativity in patients suffering from neurodegenerative disorders, the results were in favor of cognitive theories and neuroimaging data on healthy patients. In this case, the authors used a standardized measure of divergent thinking (the generation of maximum number of novel and unusual answers), the Torrance Test of Creative Thinking (TTCT; Torrance, 2004) on patients with bvFTD (will be discussed). TTCT objectively measures creativity in both verbal and figurative tasks through scoring the fluency (i.e., total responses), the flexibility (i.e., dissimilar categories that the responses belong) and originality (i.e., new responses). The results revealed that bvFTD patients performed more poorly than the control group in both verbal (fluency, originality, and flexibility) and figural (fluency, originality, and 'creative strengths') subtests. (de Souza et al., 2010). Additionally, the performance of frontal functions (e.g., inhibition, abstraction) were flawed, consistent with the literature. What does the discrepancy between the clinical observations with respect to proliferation of artistic creativity and the conceptualization of PFC and corresponding neuroimaging data convey? To answer and resolve the paradox, the definition of dementia and its subcategories will be given, the artistic products of the patients with AD and FTD will be compared and then, the further elaboration between the creativity and frontal functions, in the light of information obtained from the case studies will clarify the dilemma.

Dementia

Dementia is an umbrella term that refers to a clinical syndrome characterized by progressive loss of cognitive ability, which profoundly alters the daily lives of the patients in a way that they are able to care for themselves (Knopman et al., 2001). In addition to cognitive decline, social decline relative to adult level of competence occurs. Nevertheless, there are several paths that lead to dementia (Miller & Miller, 2013)

For instance, Alzheimer is the most common cause of dementia in the aging population. As a

gradually progressive degenerative disorder, it is mainly associated with the degeneration of medial temporal lobes and parts of the cerebral cortex (Van Buren et al., 2013) as well as with the progressive loss of visuospatial skills due to focal degeneration of both the posterior parietal and temporal regions that accompany AD (Miller & Hou, 2004). Furthermore, pathological condition of temporal-parietal junction can lead to severe problems in combining visuospatial and semantic representations of the surrounding environment (van Buren et al., 2013). The cause of AD is not known, yet there is evidence that up to 30% of the AD cases are running in the families.

Another variation of dementia, FTD represents the combination of miscellaneous conditions, which is characterized by focal onset of disease commonly in the frontal as well as in temporal lobes, and it is the primary source of dementia among individuals under 65 years old (Miller & Miller, 2013). Thus, the clinical syndromes are manifested contingent on the brain regions affected (Liu et al., 2009). In essence, the prognosis of the disease exhibits changes in personality and interpersonal conduct; where patients lose motivation, become socially disinhibited, emotionally blunted and display stereotypical and perseverative behaviors (Rankin et al., 2007). Despite the cognitive and behavioral alterations, the functioning of unaffected brain regions is spared (Viskontas & Miller, 2007) and in parallel, Mendez et al. (1996) unveiled that spared regions of brain tissue lead to functional improvements in corresponding areas.

A subtype of FTD, which is abbreviated as svPPA, is mainly characterized by language deficits in areas such as naming, semantics, and word comprehension (Rankin et al., 2007). It is progressive anomia (not being able to name the objects, comprehend words, understanding concepts), not aphasia (impediment of the ability to read and write, as well as the production and comprehension of speech), and ultimately results in profound anomia. The naming errors typically begin with within-category domain (naming hippocampus as elephant) and then spread over the superordinate categories. As a compensatory action, svPPA patients produce semantic paraphasias (producing wrong words but still in touch with the target) and the progressively weakness capability in svPPA results in circumlocution (producing word-salad to describe even simple things).

Apart from the deficiency in the language setting, patients with svPPA often display rigidity and compulsive behavior (Rankin et al., 2007). As Miller and Miller (2013) note, the condition generally operates asymmetrically, affecting the left side more often than the right side and primarily aims the anterior temporal as well as orbitofrontal neocortices, rather than the dorsolateral frontal areas (Rankin et al., 2007). Nevertheless, right temporal variant patients are more likely to exhibit social inadequacy, such as loss of empathy and even sociopathic behavior (Rankin et al., 2007)

Artistic Changes in Alzheimer's disease

The literature review of AD with respect to changing artistic capabilities offers mixed results and the prominent case studies do not confirm the notion of exacerbated artistic creativity, but instead depict alterations in the artistic creativity itself. It should be kept in mind that occasionally, alterations are considered as improvements as well (Chatterjee, 2006).

Maurer and Prvulovic (2004) investigated the alterations in painting of a professional artist and designer, Carolus Horn, who suffered from AD. According to their observation, the manifestation of his artistic alterations was in parallel with the main symptoms of the disease and they detected systematic changes. For instance, when CH drew the same painting of the bridge (Eiserner Steg) during the early and moderate stages of his disease, the two versions displayed gradually impaired spatial relations and inconsistent errors, leading to inaccurate perspective. Additionally, other drawings of CH exhibited difficulties in segregating individuality, age and gender due to his inability of accurately drawing round contours; loss in three dimensionality; changes in the use of colors (preferably bright colors); shift from naturalistic landscapes and portraits to ornamental symbols and mythical creatures that depict the combination of different species; and bearing traces of hallucinatory

stages. All in all, the artistic creativity of CH had undergone tremendous transformation.

Van Buren et al. (2013) examined the changes in the artistic style of both patients, with an attempt to quantify the alterations by adapting the Assessment of Art Attributes (AAA) (Chatterjee, Widick, Sternschein, Smith II, & Bromberger, 2010). AAA assumes that artistic products primarily have formal-perceptual (i.e., color temperature, color saturation, stroke style, depth, balance, and complexity) and content-conceptual (i.e., representational accuracy, abstractedness, realism, animacy, symbolism, and emotionality) qualities (Woods, 1991). The authors noted that formal-perceptual attributes coincide with early and intermediate visual processing, whereas the content-perceptual represents late visual processing and corresponds to different domains such as semantics and emotional systems. By doing so, van Buren et al. (2013) aimed to confirm and possibly, extend beyond anecdotal cases. The paintings of two artists with AD, William Utermohlen and Lester Potts, were rated by naïve subjects that were blind to the mental status of the painters and similar patterns emerged: like Carolus Horn, the paintings of both painters became more abstract and symbolic and meanwhile, less accurate in depictive terms and less realistic, but no significant alterations in balance, depth, and stroke (van Buren et al., 2013).

Like Carolus Horn, William Utermohlen and Lester Potts, other anecdotal case studies of painters with AD indicate augmented abstraction as the prognosis deteriorates (Chatterjee, 2004a; Crutch, Isaacs & Rossor, 2001; Rankin, 2007). As Mauer and Prvulovic (2004) suggested, the inclination for abstraction may be in conjunction with degradation of visuospatial organization and semantic knowledge of the concrete objects (van Buren et al., 2013). Miller and Hou (2004) proposes that the parietal junction and dorsolateral prefrontal pathology affects functioning of visuospatial and semantic systems and in turn, it accounts for the "appearance of ornamental symbols and mythical creatures" (843) in Carolus Horn's works as well as in Utermohlen and Potts'. In other words, as the ability of the patients with AD to accurately depict the external world declines, the drawings transform into surrealistic forms (Miller & Hou, 2004). Additionally, van Buren et al. (2013) suggest that the increased usage of symbolism and abstraction, and less attention to spatial organization (Miller & Hou, 2004) of AD patients represent their loosened touch with the external world and mental/emotional status, offering an alternative way of communication due to impaired language abilities. Noticeably, holding on to alternative ways suggests sparing of motivation and artistic impulse (Crutch et al., 2001) despite the distortion in the artistic works due to decline in organizational and executive abilities (Cummings & Zarit, 1987). In fact, the abstraction of the aforementioned artists contradicts with the finding that many of the artists with AD, suffering from similar symptoms (examined by Mini Mental State-Examination), abandoned producing artworks (Crutch et al., 2001). Thus, Crutch et al. (2001) highlights the premorbid differences in visuomotor skills, as well as the level of motivation.

All in all, Maurer and Prvulovic (2004) attempt to define the criteria of detecting, if not possible, suspecting AD characteristics in artistic works, which are regression (primitive drawings with inaccurate perspective), distortion (comic-grotesque representation), neomorphism (anatomical alteration), physiogonomy (weird facial expressions), stereotype (repetitive motives), disintegration (ignoring spatial relationships) accompanied by abstract forms, usage of ornaments, geometric and linear shapes and downsized objects.

Artistic Changes in Frontotemporal Dementia (FTD)

The literature on FTD and its special subtypes suggest that the notion of exacerbated artistic skills is more applicable for FTD patients when compared with AD, even though it is more common than AD itself (Miller et al., 1998). According to Miller and Miller (2013), left-sided and frontal activities exert control over right-sided and posterior functions but when left frontal diseases such as PPA (an umbrella term that is characterized by loss of language ability and has sub variants, such as svPPA) emerge, the right posterior functions are expected to discharge. This fact indicates that those patients "had the necessary functionalities to appreciate, integrate, and create compositions, but only when combined with spared dorsolateral and

medial frontal cortices" (Miller & Miller, 2013, p. 104). Thus, Miller and Miller (2004) note that *de novo* artistic capability was mostly noticeable within patients who had left frontal disease but spared right posterior regions. Additionally, Miller and Hou (2004) add that svPPA is a subtype of FTD, characterized by left anterior temporal lobe degeneration. Accordingly, patients with svPPA display spontaneous and novel interest in arts and systematically produce more sophisticated artistic products. Similarly, Mendez and Perryman (2003) point out that the patients who displayed artistic improvements had left temporal disruptions, suggesting that decline in the functioning of language is in line with improvement in visual processing (Hou et al., 2000). However, the examination of a patient with bvFTD unearths the paradoxical relationship between frontal symptoms and the creative mind, given with the fact that patients with behavioral variant FTD (greater involvement in frontal lobes) exhibit limited abstract thinking and creativity (de Souza et al., 2010).

de Souza and his colleagues (2014) introduce a patient with bvFTD diagnosis, named Mrs. YCFZ. The background information of the patient suggests that she did not have any interest in art, before the onset of her condition. Nevertheless, throughout the course of the disease, she compulsively began to draw. Like van Buren et al. (2013), the authors have attempted to systematically evaluate her drawings by using the Consensus Assessment Technique (CAT; Amabile, 1982) that is adopted as a questionnaire by Drago et al. (2006a) into the painting realm. There are 8 criteria to assess the level of creativity in artistic product; namely aesthetics, abstraction, closure, obsession/repetition, evocative impact, novelty, representation and technique, which are evaluated by 12 visual artists of whom were blind to the mental condition of Mrs. YCFZ. 20 of her drawings (2010-2013) were selected for evaluation that are expected to be evolved over time. Overall, the average score of the paintings that were made in 2013 surpassed the 2010 paintings on all dimensions. Furthermore, the increase was statistically significant for abstraction, obsession, and novelty scores. Additionally, the experts were allowed to comment freely and despite the heterogeneity of responses, most of them agreed upon that despite being of naïve, the drawings were carefully drawn and depicting representational themes. The experts also indicated that the repetitive usage of the characters was beneficial in forming a coherent composition. The results gain importance when it is considered that while the language and autonomy of the patient had declined over this three-year period. Yet, the artistic creativity of YCFZ was not in line with his overall cognitive deterioration (de Souza et al., 2014).

Similarly, Liu et al. (2009) analyzed the case of VW, which was similar to that of Mrs. YCFZ in the sense that while his language and behavior was deteriorating, he showed an extensive interest in painting and sculpting that he did not have prior to the disease. Changes in his personality and interpersonal conduct were the typical manifestations of FTD, with the added MND condition (progressive upper motor neuron deficiency). What makes the case of VW unique is that his depletion in terms of emotional and social functioning were not only observed in complex mental evaluation encompassing emotional reactivity, emotional competence, and emotional memory, but also in the artwork that he had produced over the course of the disease (Liu et al., 2009).

Both case studies indicate a common feature while assessing the artistic skills of patients with FTD: rigidity and obsession. Miller and Hou (2004) articulate that the need to draw the patients with FTD feel drive the visual creativity through constant repetitions, offering an opportunity to improve their skills with extensive practice. For instance, the compulsive behaviors in daily life such as water intake, eating rituals, and coin collecting etc. can manifest itself in the domain of art as well, allowing to obsessively practice his or her skills (Liu et al., 2009)

Paradoxical Functional Facilitation

How can the enhanced visual performance be interpreted in FTD cases, when the theoretical role of frontal lobes and temporal focal degeneration on creative thinking are considered? One possible explanation is Kapur's (1992) concept of

"Paradoxical Functional Facilitation". According to this concept, dysfunction in one particular sphere may allow marked performance improvement in another spare domain, due to reallocation of cognitive resources (Rankin et al., 2007). For instance, as in the case of VW, the decline in semantic knowledge due to anterior temporal pathology coupled with preserved visual processing, may create an opportunity for VW to focus on superficial aspects of the visual environment, while ignoring the 'factual information' that are attached to them (Liu et al., 2009). For instance, as Liu et al. (2009) note, since left temporal patients became less interested in the semantic connections, it allows them to decontextualize the object and to give priority on aesthetic properties. Decontextualizing may allow the patients with FTD to create visually appealing and abstract objects, which are semantically dissociated with the object itself in nature (Liu et al., 2009). Additionally, within this context, the loss of social competence, conduct and disinhibition may have boosted the artistic creativity of the patients (Miller et al., 1998), to be discussed in the following section.

Dementia, Frontal Symptoms, and Disinhibition

The beginning of this review paper attempted to summarize the role of frontal functions in exerting control over other systems and therefore, emphasizing its role on inhibition. As a reminder, the frontal lobes have intensive connections over the regions that are critically involved in memory, concept formation, and problem solving (Fuster, 2001). In the case of *de novo* artists, on the other hand, it suggests that diminished inhibition might form the source of creativity. For instance, the degeneration of the left hemisphere and correspondingly, slackening control over the right hemisphere may advocate the expression of creativity (Zaidel, 2014). Nevertheless, it should be kept in mind that if the release of right hemisphere due to the inability of the left hemisphere to exert control is the main reason of artistic creativity, then it would be expected from the patients with neurodegenerative diseases to typically display increased creativity. However, it is known that not all dementia cases display artistic behavior (Rankin et al., 2007) and accordingly, the existence of latent (dormant) artistic talent is essential for artistic manifestation (Zaidel, 2014). Therefore, uncontrolled inhibitory control might be a prerequisite but still an incomplete explanation for enhanced creativity. Regarding the case, where the inhibition is principally alleviated and therefore, the individuals become susceptible to socially inappropriate behavior, such as status-quo rejection. Would this deviation from the socially inhibitory norms facilitate creativity that is observed in FTD patients but not in AD?

The reason why it is worthwhile to propound this argument is that the ability to think creatively crucially relies on the activation of conceptual associations in semantic networks (Zaidel, 2014). As Patterson et al. (2007) note, these concepts constitute the general knowledge of and personal memories regarding to the world; and the less the inhibitory control and loss of semantics, the more the remote associations that are divergent from stereotypical and prevailing concepts (Zaidel, 2014). That is why while producing their artwork, the inhibited patients did not feel social constraints on them. As de Souza et al. (2014) note, this fact accounts for the original, unconventional, and socially inappropriate aspects of their artistic productions to a certain extent. Thus, the disinhibition of the ideas from conventional associations forms the basis for creative thinking and product. This will be called as the qualitative reason of enhanced activity.

The hypofrontality gives a meaningful insight to analyze the enhance activity of *de novo* artists quantitatively. As mentioned before, the uncontrollable need to draw on a regular fashion underlies the perseverations and stereotypical thematic patterns. As Miller and Hou (2004) describe, many artistic improvement, in fact, contain obsessive compulsive behaviors, which may account for the acquisition of the artistic skills. As de Souza and his colleagues (2014) note, "the repetitive and ritualized behaviors related to frontal dysfunction may be expressed in the artistic domain, leading to new interests in making of art or intense activity with repetitive topics and productions" (p. 15).

The Definitions of Creativity from Artistic and Neuroscientific Perspectives

The neuroscientific approach relies on evolutionary approach while defining creativity and defines it as an ability to adapt to novel environments and generate solutions when encountered with the social situations in an unconventional yet normatively acceptable way. The definition of art, on the other hand, is freed from social constraints, time and contextual boundaries and it prioritizes originality over functionality/appropriateness. For instance, an artistic point of view values inappropriate yet imaginative ideas and their expressions in any domain, while neuroscientific and evolutionary approach devalue them. That constitutes the main reason why the theoretical conceptualizations and neuroimaging data is in contrast with the clinical observations: the greater the boundaries of the definition of creativity, the more the clinical observations perplex the empirical findings.

Would it be possible to reconcile the both approaches? The accumulated knowledge in artistic and neuroscientific approaches share overlapping yet not all-inclusive backgrounds. Therefore, it is not surprising that their way of defining creativity is the main reason for the paradox to emerge, other than the notion of *de novo artists* itself. Accordingly, since these perspectives cannot be thought in a hierarchical relationship in terms of explaining the spurred artistic creativity in patients with dementia, it is the best to take in account both of them and do not reach a permanent conclusion.

Conclusion

The significant role of PFC during the creative thinking that is backed by neuroimaging data is a well-established observation. On the other hand, several clinical observations challenged the theoretical conceptualization of PFC by claiming that the patients suffering from neurodegenerative disorders that operate on PFC region, displayed marked improvements in artistic expression. The exacerbation of artistic capabilities in these patients serves as an alternative way of self-expression. Yet, the validity of these cases was questioned and this review paper attempted to compare the similarities and differences in the most common forms of dementia, which are Alzheimer's Disease and Frontotemporal Dementia. Patient studies conducted with AD patients do not necessarily approve the clinical observations by claiming that the artistic capabilities of these patients tend to show alterations and become more abstract, but do not show an overall improvement. On the other hand, the patient studies conducted with FTD patients reveal that their artistic expression indeed augments over the progression of the disorder. It should be noted that in both cases, the patients' overall functioning decline rapidly and in an irreversible fashion. The clinical observation on its own is not sufficient to claim that the overall creativity is not spurred. Instead, the need for rigidity and displayed obsessive behavior may result in practice effect that offers a unique opportunity for patients to master their skills. Additionally, Kapur's Paradoxical Functional Facilitation (1992) offers that an impairment in one domain is compensated through reallocating the resources and invest in already-spare regions. For instance, the rapid decline in semantic knowledge may allow the patient to disregard factual information of the context while focusing on superficial aspects; therefore, resulting in prioritizing aesthetics. All in all, the ultimate reason that why the clinical observations are in contrast with the neuroscientific approach is because the duo differs in the way they define creativity. While the neuroscientific approach values the adaptability in creativity, the artistic approach highlights the originality and dismiss social norms in an artistic product. This disagreement makes it difficult to resolve the paradox and prompts us to approach the issue with skepticism.

References

Crutch, S. J., Isaacs, R., and Rossor, M. N. (2001). Some workmen can blame their tools: artistic change in an individual with Alzheimer's disease. *Lancet, 357*, 2129–2133.

de Souza, L. C., Volle, E., Bertoux, M., Czernecki, V., Funkiewiez, A., Allali, G., et al. (2010). Poor creativity in frontotemporal dementia: a window into the neural bases of the creative mind. *Neuropsychologia, 48*, 3733–3742.

de Souza, L. C., Guimares, H. C., Teixeira, A. L., Caramelli, P., Levy, R., Dubois, B., Volle, E. et al. (2014). Frontal lobe neurology and the creative mind. *Frontiers in Pyschology, 5*, 1-21.

Drago, V., Crucian, G. P., Foster, P. S., Cheong, J., Finney, G. R., Pisani, F., et al. (2006a). Lewy body dementia and creativity: case report. *Neuropsychologia, 44*, 3011–3015.

Fornazzari, L. R. (2005). Preserved painting creativity in an artist with Alzheimer's disease. *European Journal of Neurology, 12*, 419–424.

Gonen-Yaacovi, G., de Souza, L. C., Levy, R., Urbanski, M., Josse, G., and Volle, E. (2013). Rostral and caudal prefrontal contribution to creativity: a meta-analysis of functional imaging data. *Frontiers in Human Neuroscience, 7*,465.

Liu, A., Werner, K., Roy, S., Trojanowski, J. Q., Morgan-Kane, U., Miller, B. L., et al. (2009). A case study of an emerging visual artist with frontotemporal lobar degeneration and amyotrophic lateral sclerosis. *Neurocase, 15*, 235–247.

Maurer, K., and Prvulovic, D. (2004). Paintings of an artist with Alzheimer's disease: visuoconstructural deficits during dementia. *Journal of Neural Transmission, 111*, 235–245.

Mendez, M. F., and Perryman, K. M. (2003). Disrupted facial empathy in draw- ings from artists with frontotemporal dementia. *Neurocase, 9*, 44–50.

Miller, B. L., Cummings, J., Mishkin, F., Boone, K., Prince, F., Ponton, M., et al. (1998). Emergence of artistic talent in frontotemporal dementia. *Neurology, 51*, 978–982.

Miller, B. L., and Hou, C. E. (2004). Portraits of artists: emergence of visual creativity in dementia. *Archives of Neurology, 61*, 842–844.

Rankin, K. P., Liu, A. A., Howard, S., Slama, H., Hou, C. E., Shuster, K., et al. (2007). A case-controlled study of altered visual art production in Alzheimer's and FTLD. *Cognitive and Behavioral Neurology, 20*, 48–61.

van Buren, B., Bromberger, B., Potts, D., Miller, B., and Chatterjee, A. (2013). Changes in painting styles of two artists with Alzheimer's disease. *Psychology of Aesthetics, Creativity, and Arts,7*, 89–94.

Zaidel, D. W. (2014). Creativity, brain, and art: biological and neurological considerations. *Frontiers in Human Neuroscience, 8*, 1-9.

Metaphoric Play: The World's a Stage

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Pretend play is a form of play that requires one to perform nonliteral actions. Although this activity may seem to be done solely for fun, many researchers have found that pretend play shares underlying structures with language, theory of mind and counterfactual reasoning. This current literature review will first define pretend play and its forms, then it will concentrate on the similarities between metaphor comprehension and pretend play. Lastly, given pretend play's positive effect on language development and the similarities between metaphor use and pretend play, the article will suggest a brief research design.

Keywords: pretend play, metaphor, language development

All of us, at some point in our lives, have either engaged in pretend play or have had the pleasure of observing a child doing it. I personally remember myself riding my bicycle with a rope tide around its handlebars, as if it were the reins of a horse, racing an imaginary opponent all around the house after watching the animated movie "Prince of Egypt". Just like this one, many examples of pretend play can be provided. However, this being the case, it is difficult to come up with a clear-cut definition of what play and pretend play is (Weisberg, 2015). Hence, in the first of the three main sections of this review, I will begin by explaining what pretend play is and how it can be distinguished from other forms of play. Then, I will define what a metaphor is and go through the literature on the development of metaphor comprehension in children. Lastly, since, engaging in pretend play has been found to have various positive effects on children's language skills (e.g. verbalization, vocabulary, language comprehension, concentration) (Smilansky & Shefatya, 1990; Bodrova & Leong, 2003), I will concentrate on the possible relationship between metaphor comprehension and engaging in pretend play and come up with a research design that might be able to find out if engaging in pretend play predicts future comprehension of metaphors in children.

What is Pretend Play?

Before one tackles the question of what pretend play is, it is important to clearly define what play is; on this note, examining the four main criteria of play suggested by Krasnor and Pepler (1980) which are flexibility, positive affect, nonliterality and intrinsic motivation is crucial. The flexibility criterion emphasizes that play behaviours are very different from the ones that are engaged in real life regarding their form and content (Krasnor & Pepler, 1980). For example, when engaged in play, children might act in an exaggerated fashion, and while playing, they might change the functions of certain toys or tools that they are playing with such as treating a stick to be a spoon (change in content) (Lillard, Lerner, Hopkins, Dore, Smith & Palmquist, 2013). Positive affect underlines the idea that children who are engaged in play seem to have fun (Lillard et.al., 2013). Nonliterality, on the other hand, refers to the fact that behaviours engaged in play, while symbolically carrying a similar meaning to its original use, do not carry their usual meanings (Lillard et.al., 2013). A good example demonstrating this characteristic of play comes from a play of rough and tumble. In this play, when a child acts as if he is hitting his friend, he does not have the intention of hurting him; however, the act of, let's say, throwing a punch carries the same meaning it usually carries. Lastly, intrinsic motivation refers to the fact that play is a voluntary activity that one engages in solely for fun (Lillard et.al., 2013).

With these characteristics of play laid-out by Krasnor &Pepler (1980) and with the support of various other research showing the positive cognitive, social and emotional effects play has on individuals, it has been argued by the United Nations High Commission for Human Rights, in recent years, that engaging in play is, in fact, a right of every child (Lillard et.al., 2013). By accepting play as a right, the UN both aimed to protect children being forced to work in harmful jobs (e.g. prostitution) and to ensure all children have the same opportunity to enjoy an adequate standard of life and education. As a result, nowadays, entire school curricula are designed based on pretend play (Zigler & Bishop, 2004). However, it is important to note that most of the research done on this topic comes from studies that have been conducted with children from Western cultures, and there is evidence suggesting that many non-Anglo cultures do not give the same importance to pretend play, and as a result, children from these cultures tend to engage in pretend play much less (Weisberg, 2015; Lillard et.al. 2013). On a similar note, culture also seems to drastically affect the themes of the pretend play children engage in. For example, compared to Chinese children, American children have been found to engage in plays that have a higher degree of fantasy elements (Haight, Wang, Fung, Williams & Mintz, 1999). Nonetheless, when one examines the whole literature on pretend play, it is reasonable to believe that at least some form of pretend play is universal, since it tends to occur approximately at around the same age in a variety of cultures (Lillard et.al. 2013).

But what is pretend play, really? What is it that distinguishes pretend play from other forms of play? And what makes it important to study? Actually, it is not that hard to separate pretend play from various other forms of play, since it involves children acting as if, such that the actions that they engage in are not meant to reflect reality. Instead they are made to make others around them believe as if they are. In this way it can be argued that it is very similar to acting (Weisberg, 2015). However, despite this straightforward requirement mentioned, it is difficult at times to make a clear distinction between episodes of pretend play and other types of play (Weisberg, 2015). For example, when observing two children who are engaged in a play of rough-and-tumble, it is challenging to figure out if they are merely interacting physically or pretending to be superheroes in a fight. As it is the case for this example, even though some kind of imaginative or nonliteral quality is essential for an action to be considered as pretence, it can be hard for an observer to realize it. Moreover, this pretence quality may occur during some parts of the play, meaning the children might focus on their roles as superheroes more or less throughout the fight thus switching their actions from being purely physical play to pretend play each time. Therefore, research on pretend play has to be done very carefully in order not to identify physical play as being pretend play and vice versa (Weisberg, 2015).

Forms of Pretend Play:

To be able to study pretend play in detail, researchers, over the years, have come up with three main methods/ techniques/ designs: object substitution, pretending with invisible objects and imaginary companions (Weisberg, 2015). The earliest form of pretending, which usually occurs around 18 months of age, is considered to be object substitution. In such a play, the child uses an object as if it were something else (Bosco, Friedman, Leslie, 2006; Fein, 1981; Nicolich, 1977; Onishi, Baillargeon, Leslie, 2007). The classic example given for this kind of play is the banana example, in which the child acts as if a banana is a telephone. The second form of pretend play tends to occur in the early preschool years; children begin to engage in plays where they pretend to use tools or objects that are invisible and which only exist in the their imagination (Weisberg, 2015). As one might guess, this is a more complex form of play since the elements that constitute it do not have physical equivalents in the immediate real world (Taylor & Carlson, 1997). Lastly, as the name suggests, children tend to engage in pretend play in which they interact with imaginary companions, (i.e. friends) (Weisberg, 2015). The imaginary companion that the child is interacting with can be completely invisible and thus, may only exist in the child's imagination; or it can be an embodied object, which the child has assigned some kind of

personality to (Weisberg, 2015). Moreover, it is also important to note that some children might engage in some form of pretend play in which they act as if they are someone they are not, like Batman, or might engage in imaginary worlds where there are multiple pretend friends who engage with one another (Carlson & Taylor, 2005). There are also children, which create paracosms, which are imaginary worlds where various imaginary friends live according to a set of internal rules set by the child (Root-Bernstein, 2013). On this note, it is crucial that I make it clear that this is absolutely normal; it cannot be concluded, on the sole information that a child is engaging in such pretend play, that the child has mental abnormalities. On the contrary, such a child can be argued to have a more advanced language, theory of mind, and counter-factual reasoning skills compared to his peers (Weisberg, 2015).

Language, Comprehension of Metaphors and Pretend Play:

As the definition made earlier implies, one of the most fundamental features of pretend play is its symbolic nature. During pretend play, the actions that the child engages in do not have the typical effects they have in reality; they rather take place in pretend, imaginary frames (Weisberg, 2015). Furthermore, keeping this feature in mind, one can argue that in cases of pretend play, actions the individual engages in are just like words; in that they too have symbolic meanings that are used to refer to objects in the real world. Thus, as Weisberg (2015) suggests, pretend play, by providing children a pretend frame in which they can practice using various symbolic relationships, can fasten their language acquisition process. In support of this hypothesis, there is correlational evidence demonstrating that at 13 months of age, toddlers' language comprehension skills and at 20 months of age, their semantic diversity (calculated as the number of different semantic categories used) in language are positively correlated with their symbolic play routines (Tamis-LeMonda & Bornstein, 1994). Moreover, the same study also underlines the fact that the 13 month-olds' symbolic play successfully predicted their semantic diversity in language at 20 months of age, suggesting that engaging in pretend play was indeed helpful in developing toddlers' language skills. However, it is very important to note that from these findings, one cannot conclude that pretend play is absolutely necessary for language development; as stressed earlier, one can solely conclude that pretence, by creating an environment which allows the child to practice the use of various symbolic relations, plays a supporting role in language development (Weisberg, 2015).

Due to the suggested existence of a relationship between language and pretend play, as the findings above hint, although it is not ground-breaking to think of a possible connection between pretend play and children's comprehension of metaphors, when examined closely, one can see that the similarity the two symbolic understandings share has more to offer than it first meets the eye. To understand this similarity, one has to examine closely the object substitution form of pretend play; the classic example given for this kind of play, as mentioned earlier, is the banana example, in which the child acts as if a banana is a telephone. However, it is important to note that the child chooses this object out of various other possible objects, meaning that this choice is not arbitrary but depends on a quality the banana holds, which, in this case, appears to be the shape of the fruit. When examined in such a way, every pretend play that children engage in is essentially a metaphor, since the pretending being done is done with a feature of the object being substituted for in the mind. This being the case, in order to suggest a longitudinal research design aiming to find a possible relationship between children's engagement in pretend play and metaphor comprehension, it is crucial to go over some of the literature on the development of children's metaphor comprehension.

Previous research in the field considers figurative speech (word or phrase that has a meaning other than its literal meaning) to be mainly composed of metaphors and metonymies (Rundblad & Annaz, 2010). Traditionally, the distinction between these two concepts relies on similarity and continuity. When one is trying to differentiate between the uses of the word "face" in the sentences "There is a new face on the clock" and "There is a

new face in the school", one makes use of such a distinction. In this example, the former is a metaphor, since a part of the human body is being compared to a part of a clock; on the other hand, the latter is a metonym because the word 'face' is substituted for an individual (Rundblad & Annaz, 2010). Moreover, throughout the years, many theories and models of figurative language have been constructed in order to understand how exactly people understand both metaphors and metonymies, but one assumption seems to remain the same: a metaphor is more complex than a metonymy (Rundblad & Annaz, 2010). However, there seems to be a lack of consensus as to which methods are to be used to study people's understanding of metaphors. Since the early days of the field, various methods have been used in numerous studies. For example, Winner and Engel (1980) considered one to understand the use of metaphors if the individual classified an item as sharing perceptual similarities to another, whereas Waggoner, Messe and Palermo (1985) considered one comprehending metaphors if they were able to recall and construct the meaning of both literal and metaphorical expressions depending on the context they were presented in. Due to these theoretical discrepancies that exist in the field, until recently, we do not have a clear understanding regarding at what age metaphor comprehension emerges and what developmental trajectory it follows. However, a recent study done by Rundblad & Annaz (2010) indicates that both the comprehension of metaphors and metonymies continue to improve until the individual reaches adulthood. Furthermore, the study also shows that people have a harder time understanding metaphors than metonymies.

Does engaging in pretend play predict future comprehension of metaphors in early childhood?

So, keeping in mind the findings mentioned throughout the paper, is it possible to come up with a research design that might potentially show that engaging in pretend play more and engaging in more complex forms of pretend play, in fact, predict higher levels of metaphor comprehension in early childhood?

First of all, since we want to show that engaging in pretend play has an effect on children's metaphor comprehension down the line, a longitudinal study is necessary. Given that children start engaging in pretend play at around 18 months of age and the fact that between the ages of 3 and 5 is considered to be the "high season" of pretend play, it is important that we start measuring children's engagement in pretend play during these time periods (Singer & Singer, 1990). Thus, I would measure children's engagement in pretend play at 2, 3, 4 and 5 years of age. At this point, however, a very important question arises: "How will I measure this?" Since, to my knowledge, no objective and experimental method of measuring pretend play exists, I will suggest a novel method. The only way that appears to me that one can measure such a variable is through a play setting; and to create such a setting, I suggest that we go over the most cited observational studies on pretend play and come up with a list of most reported examples of such play. This, I would guess, in light of the literature review I have done, would provide us with a list of toys and objects that children tend to use while they are engaging in pretend play. Of course, this would mean that this study can only be done with children from Western cultures since the observational findings reported in the literature mostly consist of samples of such cultures. However, at this point, I don't think this restriction is necessarily a bad thing, since it is too early to be concerned about the cultural differences that might exist. Having come up with such a list, we could design a play setting where, according to the literature, the most engaged with toys and objects will be presented to children for them to play with, and each child can receive a score depending on the number of times they have engaged with a toy in pretend play form and the actual form of pretend play being done.

On the other hand, to measure children's metaphor comprehension ability, I suggest that we use the method designed by Rundblad and Annaz (2010). In their study, they came up with an experimental task in which the participants are presented with 10 simple picture-stories of 10 different metaphors; each story reportedly consists of four pictures and each story has a narrative that the experimenter reads to the participants (Rundblad & Annaz, 2010). The idea is simple, if the child manages to

understand the metaphor used in the story and report it to the experimenter, he/she succeeds in the task. Thus, using this method, we can measure 50-month-old children's metaphor comprehension ability. Having both children's metaphor comprehension and pretend play scores through the ages of 2 to 5, one would be able to see if indeed children who engage in pretend play end up understanding metaphors at a higher rate as they get older. In light of this review, I would predict that this would be the case.

In conclusion, this literature review demonstrates that engaging in pretend play has various positive effects on language and specifically, by providing children with the opportunity to practice various kinds of symbolic relationships, can fasten children's acquisition of language. Thus, I believe that by conducting the study suggested, one can show the possible existence of a relationship between children's metaphor comprehension and pretend play.

References

Bodrova, E., & Leong, D. J. (2003). The Importance of Being Playful. *Educational Leadership*, 60(7), 50-53.

Bosco, F. M., Friedman, O., & Leslie, A. M. (2006). Recognition of pretend and real actions in play by 1-and 2-year-olds: Early success and why they fail. *Cognitive Development*, 21(1), 3-10.

Carlson, S. M., & Taylor, M. (2005). Imaginary companions and impersonated characters: Sex differences in children's fantasy play. *Merrill-Palmer Quarterly*, 51(1), 93-118.

Fein, G. G. (1981). Pretend play in childhood: An integrative review. *Child development*, 1095-1118.

Haight, W. L., Wang, X. L., Fung, H. H. T., Williams, K., & Mintz, J. (1999). Universal, developmental, and variable aspects of young children's play: a cross‐cultural comparison of pretending at home. *Child development*, *70*(6), 1477-1488.

Krasnor, L. R., & Pepler, D. J. (1980). The study of children's play: Some suggested future directions. *New Directions for Child and Adolescent Development*, *1980*(9), 85-95.

Lillard, A. S., Lerner, M. D., Hopkins, E. J., Dore, R. A., Smith, E. D., & Palmquist, C. M. (2013). The impact of pretend play on children's development: A review of the evidence. *Psychological bulletin*, *139*(1), 1.

Nicolich, L. M. (1977). Beyond sensorimotor intelligence: Assessment of symbolic maturity through analysis of pretend play. *Merrill-Palmer Quarterly of Behavior and Development*, 23(2), 89-99.

Onishi, K. H., Baillargeon, R., & Leslie, A. M. (2007). 15-month-old infants detect violations in pretend scenarios. *Acta Psychologica*, 124(1), 106-128.

Root-Bernstein, M. M. (2013). 27 The Creation of Imaginary Worlds. The Oxford handbook of the development of imagination, 417.

Rundblad, G., & Annaz, D. (2010). Development of metaphor and metonymy comprehension: Receptive vocabulary and conceptual knowledge. *British Journal of Developmental Psychology*, *28*(3), 547-563.

Singer DG, Singer JL. *The House of Make-Believe: Children's Play and the Developing Imagination*. Cam- bridge, MA: Harvard University Press; 1990.

Smilansky, S., & Shefatya, L. (1990). Facilitating play: A medium for promoting cognitive, socio-emotional and academic development in young children. *Psychosocial & Educational*.

Tamis-LeMonda, C. S., & Bornstein, M. H. (1994). Specificity in mother-toddler language-play relations across the second year. *Developmental Psychology*, *30*(2), 283.

Tamis-LeMonda, C. S., & Bornstein, M. H. (1994). Specificity in mother-toddler language-play relations across the second year. *Developmental Psychology*, *30*(2), 283.

Taylor, M., & Carlson, S. M. (1997). The relation between individual differences in fantasy and theory of mind. Child development, 68(3), 436-455.

Waggoner, J. E., Messe, M. J., & Palermo, D. S. (1985). Grasping the meaning of metaphor: Story recall and comprehension. *Child development*, 1156-1166.

Weisberg, D. S. (2015). Pretend play. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6*(3), 249-261.

Winner, E., Engel, M., & Gardner, H. (1980). Misunderstanding metaphor: What's the problem?. *Journal of Experimental Child Psychology*, *30*(1), 22-32.

Zigler, E. F., & Bishop-Josef, S. J. (2004). Play under siege. *Yale's Center in Child Development and Social Policy. In*, *21*, 1-4.