

Does Labelling Preinventive Forms Cause Functional

Fixedness?

By Anton Preis

Committee: Professor Drew Walker, Professor Taylor Scott, and Michael Allen

UC San Diego Cognitive Science Honors Thesis

June 3rd, 2020

Abstract

Functional fixedness is the lessened ability to think of a novel function of an object due to fixating on the object's current function (Duncker, 1945). In a paradigm created by Finke (1990), multiple functions were generated for the same ambiguous object. We adopted Finke's paradigm to investigate the relationship between functional fixedness and labelling. The main purpose of this study is to understand how generating a label for an object affects functional fixedness. A secondary purpose of this study is to empirically test Finke's observation that the second function is the most difficult function to come up with. This study uses the amount of time taken to generate a novel function for the same object as a quantitative measurement of functional fixedness. This measurement is referred to as 'spanning time'.

Introduction

Preinventive forms are ambiguous objects used to create novel inventions and novel concepts (Finke 1990). To create a novel invention, subjects must first combine 3 object parts into a whole preinventive form. Then, subjects are given a semantic category, like 'Furniture', in which they must generate a function in mind for the preinventive form that fits within the semantic category. After generating a function in mind, subjects name the preinventive form, draw it, and then describe its function (Finke, 1990). This paradigm was created to investigate how the creativity of inventions is affected by whether subjects or experimenters choose the object parts, as 3 object parts had to be chosen out of 15, and semantic categories, as 1 semantic category had to be chosen out of 8 (Finke 1990). It was found that highly creative inventions were most common when subjects chose their own objects parts and when experimenters chose the semantic category (Finke, 1990). Finke (1990) also created another paradigm, which was not empirically implemented, in which one preinventive form was given multiple functions and names spanning across eight different semantic categories. Finke (1990) anecdotally noted that the second function was the most difficult function to come up with in this latter paradigm. Finke (1990) subjectively attributed this to being focused on the first function which hindered his ability to come up with the second function, but after coming up with the second function it was easier to generate the remaining functions. This anecdotal observation highlights how this latter paradigm offers a promising basis from which functional fixedness can be studied. This study adopts and adds to this latter paradigm, and refers to this paradigm as the 'spanning paradigm'.

Functional fixedness is the lessened ability to think of new or unique functions for an object, due to a mental fixation on the object's current function (Duncker, 1945). A simple example of this is if one wanted to change a lightbulb, but were fixated on a chair's function as a seat, you might fail to see its utility as a step-stool. A classic illustration of how such fixations can interfere with problem solving is an experiment that tasked subjects with hanging 3 lighted candles on a door (Duncker, 1945). At their disposal, the subjects had small boxes, tacks, a box of matches, and candles. In the first condition, the small boxes were presented as having a utility: they were used to hold tacks. In the second condition, the boxes were presented next to the tacks as independent objects without an existing utility. Subjects were more likely to figure out the solution in the second condition when the boxes did not have an existing utility. Duncker suggested that this was due to "functional fixedness" – subjects in the former condition fixated on the function of the boxes, which was to contain tacks, which lessened the ability to think of using the small boxes as platforms (Duncker, 1945).

Functional fixedness literature also shows that subtle linguistic manipulations can modulate functional fixedness. For example, it is known that labelling specific parts of an object can affect functional fixedness. One study presented subjects with a problem in which the solution required using a screwdriver's blade to conduct electricity. Separately labelling both the blade and handle, instead of the whole object, increased problem solving (Glucksberg & Danks, 1968). This does not seem to occur simply because the existence of two components is emphasized; differentiating the blade and the handle by hue or gloss didn't increase problem solving. This suggests that language may be more powerful in directing our attention toward functions compared to perceptual properties (Glucksberg et al., 1968). Similarly, in a

subsequent experiment, Glucksberg et al. (1968) found that subjects performed better on a functional fixedness task when they were presented with a familiar object with a non-sense label compared to the actual object name. For example, when a wrench was labelled as “PEEM” subjects were more likely to use the wrench in a novel fashion compared to subjects presented with the label as “wrench”. Glucksberg et al. (1968) noted that original labels of objects may be associated with the object’s habitual use, while nonsense labels offer a representation that doesn’t force the participant to cognitively process this habitual use.

This leads to the first purpose of this study, which is to understand how naming a preinventive form may affect functional fixedness in the ‘spanning paradigm’. The ‘spanning paradigm’ involves generating a name in association with every generated function. The act of generating a novel name for an object, or any referent, is called creative naming (Carroll, 1981). We hypothesize that creative naming may force subjects to additionally process the current function of a preinventive form leading subjects to increase their focus on the current function, and that this should result in subject’s having more difficulty in releasing from functional fixedness when asked to name objects (Yagolkovskiy & Medvedev, 2019). This additional processing is thought to be due to subjects, after already coming up with a function for the preinventive form, having to process the function again when using it as context to name the preinventive form. In this study, we test if creative naming affects the fixation a subject has on an object’s given function as measured by the amount of time it takes to generate a novel function for the same object. This amount of time is referred to as ‘spanning time’ in this study. Spanning time is used as the term to refer to this measurement as subjects must span different semantic categories for the same preinventive form (Finke, 1990).

The secondary purpose of this study is to empirically test an anecdotal observation by Finke (1990) in which he noted that the second function was the most difficult function to come up with when generating 8 different functions for the same preinventive form. Finke (1990) attributed this to having to overcome a mental focus on the first function to generate the second function. Once the second function was generated, Finke (1990) noted that all subsequent functions were easier to generate. In this study, we test to determine whether the second function is the most difficult function to come up with by analyzing whether the second function exhibits the greatest mean spanning time out of all other functions.

Methods

In this experiment, we adapted a creativity paradigm developed by Finke (1990). This paradigm is referred to as the 'spanning paradigm'. All subjects first mentally combined a preinventive form from three object parts (see Figure 1), and then sketched this preinventive form (see Figure 2). Subjects were then presented, sequentially, with 6 different semantic categories (e.g., furniture) and had to generate functions for the object they had created that fit within each category (see Appendix D). We manipulated whether subjects named the object after generating a new function, in the naming condition, or did not name the object after generating a new function, in the non-naming condition. This experiment employs a within-subjects design, in that each subject participated in both the naming condition and the non-naming condition. Finke (1990) referred to the generation of functions across multiple semantic categories as 'spanning'. To quantitatively measure functional fixedness, in this study we use

‘spanning time’ to refer to the amount of time it takes a subject to generate a novel function, within a different semantic category, for the same preinventive form.

Participants

86 undergraduate students attending the University of California, San Diego participated in this study for course credit. The data from 6 subjects were removed from this study due to those subjects not properly following the experimental procedure, either through incorrectly combining preinventive forms or self-interrupted task performance. Undergraduates used the UC San Diego Sona System which is an online platform allowing undergraduate students to sign-up for participation in Psychology, Linguistics, and Cognitive Science experiments affiliated with the University of California, San Diego.

Materials

Handouts

3 types of handouts were used in this study. The first handout was the ‘Rules’ handout (see Appendix A). The ‘Rules’ handout consisted of the rules needed to create a preinventive form from 3 object parts. Each subject was given one ‘Rules’ handout prior to starting the experiment on the computer. The second handout was the ‘Base Form’ handout (see Appendix B). The ‘Base Form’ handout consisted of a space in which subjects sketched the preinventive form they created from mind to paper. The experiment referred to the preinventive form as a ‘Base Form’ for ease of user-experience. Each subject was given two ‘Base Form’ handouts prior to starting the experiment on a computer. The third handout was the ‘Practice’ handout (see

Appendix C). The 'Practice' handout consisted of an overview of the two main tasks of the experiment, namely, creating a Base Form and generating novel functions for the Base Form. Each subject was given one 'Practice' handout prior to starting the experiment. A researcher reviewed the 'Practice' handout with each subject in a group setting prior to starting the experiment. This was done to minimize procedural confusion when performing the experiment.

Semantic Categories

The 6 semantic categories used in this experiment to guide the generation of functions attributed to an ambiguous object were 'Furniture', 'Toys and Games', 'Transportation', 'Scientific Instruments', 'Weapons', and 'Tools and Utensils' (Finke, 1990). Finke (1990) referred to these semantic categories as superordinate categories.

Object Part Sets and Ambiguous Objects

The object parts used in this study are borrowed from Finke (1990). There are 2 different object part sets (see Figure 1). Each set consists of 3 distinct object parts. One of the sets consisted of an object part with a special case in which one object part can be bent. Subjects mentally combined either set of object parts into a preinventive form for each condition, and then sketched the preinventive form from mind to paper (see Figure 2).

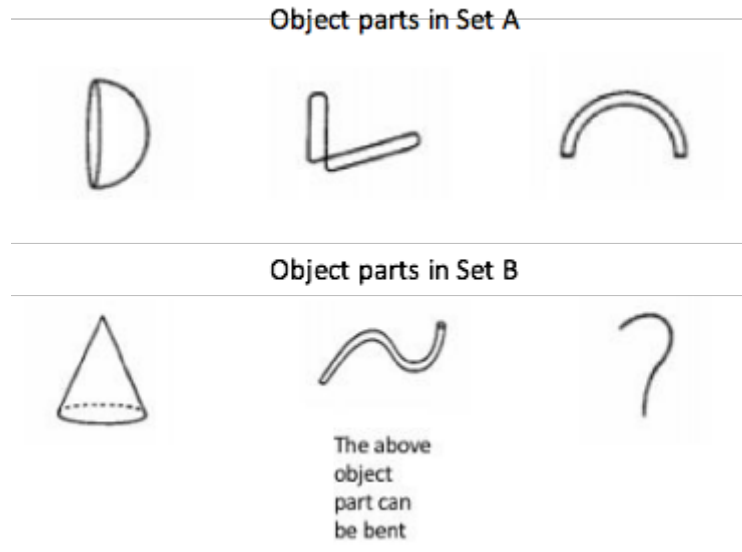


Figure 1. Subjects were presented with object parts in Set A and object parts in Set B over the course of two conditions, which were both mentally combined to create two different preinventive forms

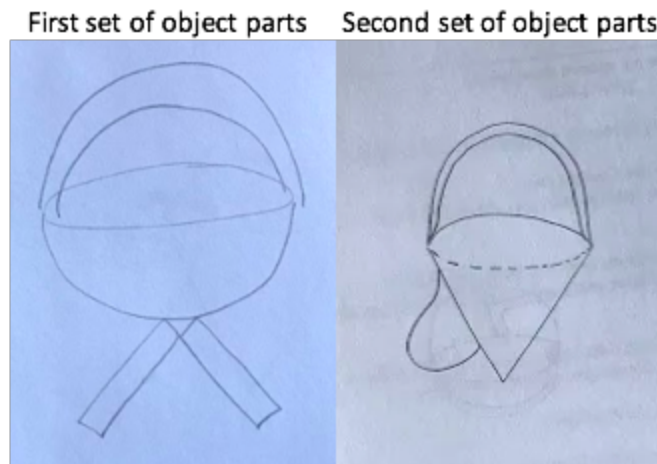


Figure 2. Examples of preinventive forms created by different subjects using the first set of object parts (on the left) and the second set of object parts (on the right)

Procedure

Practice

Subjects practiced performing experimental tasks prior to performing the real experiment. The first task that subjects practiced was to combine 3 object parts into a preinventive form in mind, and then to draw the preinventive form from on paper. Subjects also practiced generating functions for the preinventive form using semantic categories that were not used in the real experiment, which were personal items and appliances (Finke, 1990). The rules for how to combine the 3 object parts, and the rules for how to generate functions were both introduced during practice. Only two functions were generated for a preinventive form during practice.

Experimental Procedure

The experiment was conducted on a computer via Qualtrics. The experiment itself consisted of 2 conditions. In each condition, subjects were presented with one of the object part sets (object part sets were counterbalanced) and were given 2 minutes to mentally combine the parts to create a preinventive form, and then sketch the preinventive form. After they created the preinventive form, subjects sequentially generated 6 novel functions for this form. In each trial subjects were randomly presented with one of the six semantic categories, and had to generate a novel function for the preinventive form within this category. Once the subject had a function in mind, they were instructed to immediately advance to the next screen. In the non-naming condition subjects had to type a description of the function they had in mind for the preinventive form within the given semantic category (see Figure 3). The naming

condition had subjects perform the same procedure as the non-naming condition, except subjects not only wrote a description of a function, but also wrote a name for the object they had just written a description for (see Figure 4). For each trial, we recorded spanning time, which is the amount of time it took to come up with a novel function in mind when presented with a new semantic category. This was measured as the time recorded from the onset of the presentation of the screen instructing subjects to generate a function within a new semantic category to the point in time in which subjects clicked an icon to advance to the next screen after having a clear function in mind. Examples of functions and their associated names that subjects came up with are shown in Appendix D. In the beginning of each condition, subjects were encouraged to read the 'Rules' handout for how to mentally combine object parts. And before starting the trials for each condition, subjects were reminded of the rules for how to generate functions.

Randomization

Each object part set was displayed once per subject, and each set was randomly assigned to either the naming condition or the non-naming condition. The order of the conditions was randomly presented. For example, if a subject was first presented with the naming condition paired with Set B, then that subject would subsequently be presented with the non-naming condition paired with Set A.

General procedure for non-naming condition

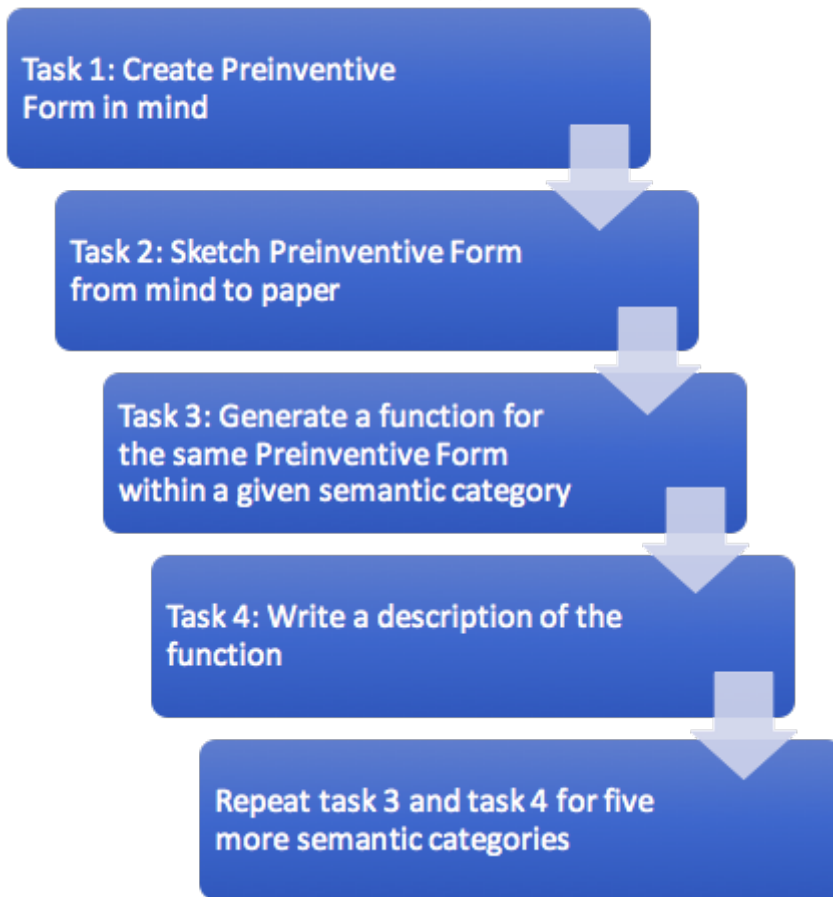


Figure 3. Subjects performed a general procedure that involved creating a preinventive form in mind, sketching the preinventive form on a piece of paper, and generating 6 functions for the preinventive form each within a different semantic category

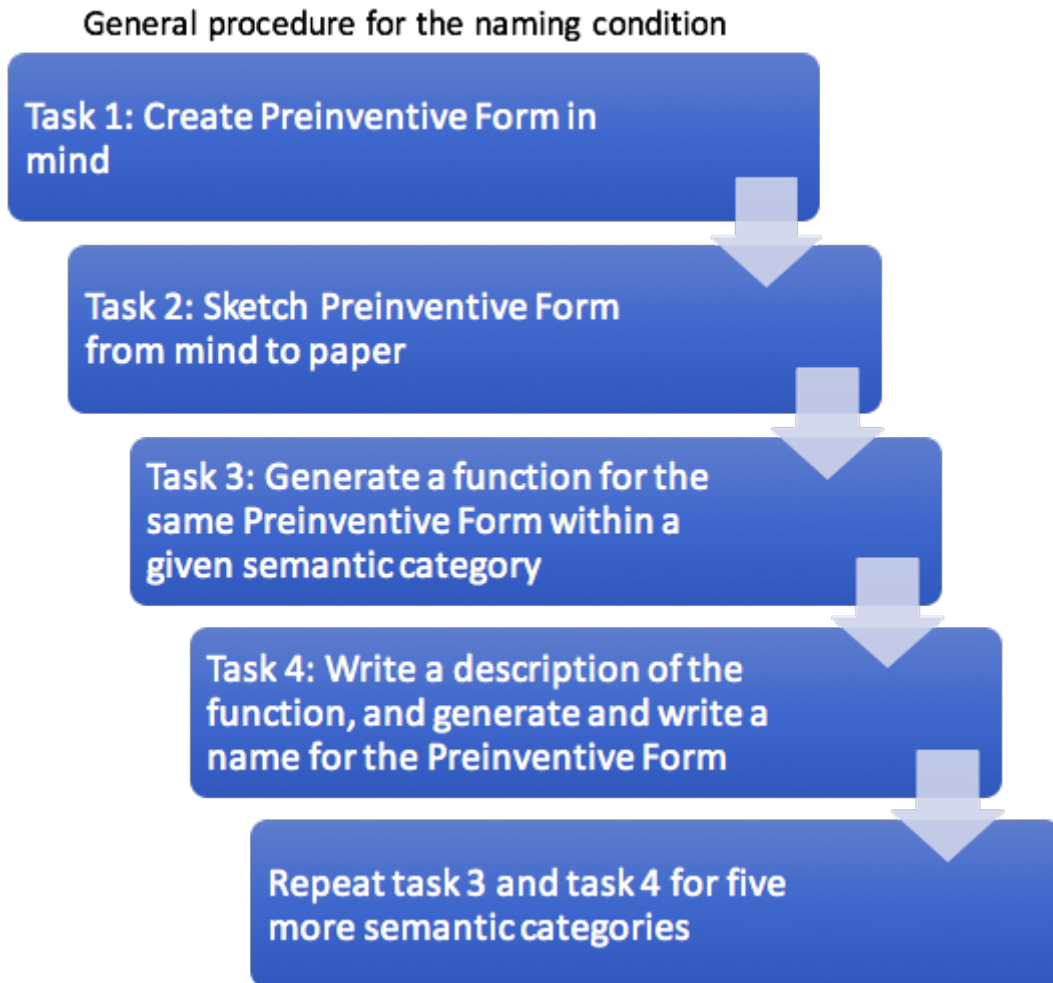


Figure 4. Subjects performed a general procedure that involved creating a preinventive form in mind, sketching the preinventive form on a piece of paper, generating 6 functions for the preinventive form each within a different semantic category, and generating one name in association with each function (i.e., subjects generate 6 names in total in the naming condition)

Results

Data Analysis

How Labelling Affects Spanning Time

The mean spanning time for the naming condition and non-naming condition were 21.4 seconds and 21.2 seconds, respectively. A paired-samples t-test was conducted to compare mean spanning times in the naming condition versus the non-naming condition. There was not a significant difference between the naming condition ($M = 21.4, SD = 18.5$) and non-naming condition ($M = 21.2, SD = 19.3$); $t(79) = 0.142, p = 0.887$.

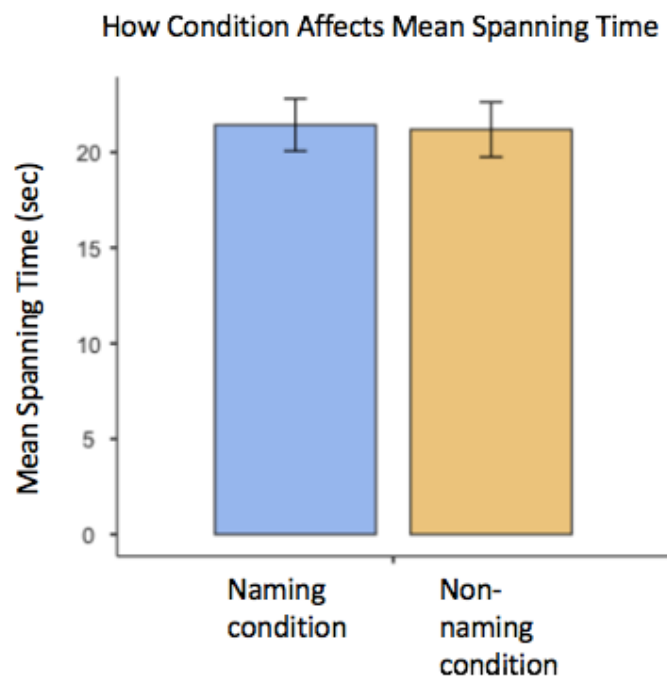


Figure 5. The mean spanning time in the naming condition was 0.2 seconds greater than the mean spanning time in the non-naming condition, however no significant difference was found between both mean spanning times

Testing for Release from Fixation on the First Function

Finke (1990) anecdotally noted that upon sequentially spanning a preinventive form over 8 different superordinate categories, the second function was the most difficult to come up with. He subjectively noted that this may be due to overcoming a mental focus on the first function to generate the second function. Then, after generating the second function, he noted that subsequent functions were easier to generate. Based on this observation we were interested in whether the second sequential mean spanning time would be the greatest mean spanning time out of all 6 spanning times within a condition. Results indicated that the second mean spanning time was not the greatest spanning time compared to all other trials (see Figure 6). However, when analyzing the second mean spanning time between the naming condition and non-naming condition, the second mean spanning time was the greatest spanning time in the naming condition, while the second mean spanning was not the greatest in the non-naming condition (see Figure 7). Analysis of the second mean spanning time compared to all other spanning times was not tested to determine a significant difference.

How Trial Order Affects Mean Spanning Time Within one Condition

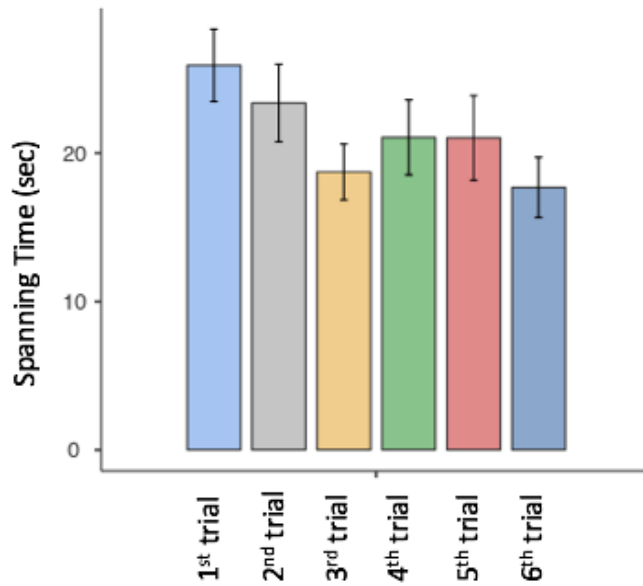


Figure 6. The second mean spanning time, taken from data for the naming and non-naming conditions, was not the greatest mean spanning time compared to the other five mean spanning times within one condition (as opposed to across both conditions a subject participates in)

How Trial Order and Condition Affect Mean Spanning Time Within one Condition

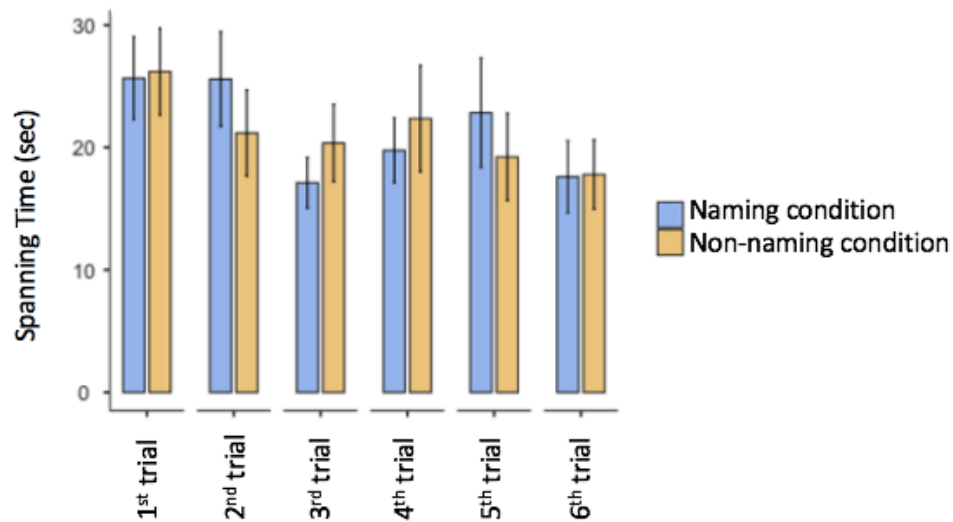


Figure 7. The second mean spanning time, in the naming condition, was the greatest mean spanning time, whereas the second mean spanning time, in the non-naming condition, was not the greatest mean spanning time within one condition (as opposed to across both conditions a subject participates in)

Exploratory Analysis

Spanning times decreased significantly from the first span to the last span (see Figure 8). This indicates that a fatigue effect, in that subjects may have gradually lost motivation to thoroughly complete the tasks of the experiment over time. Given that a fatigue effect may have accounted for the gradual decrease in mean spanning times from the first trial to the twelfth trial, an analysis of spanning times for only the first 6 spans was conducted. Results indicated that the mean spanning time taken from only the first 6 spanning times for the naming condition was 23.8 seconds, while the mean spanning time for the non-naming

condition was 29.6 seconds. An independent-samples t-test was conducted to compare mean spanning times in the naming condition versus the non-naming condition for only the first 6 trials. There was not a significant difference between the naming condition ($M = 24.6$, $SD = 16.4$) and non-naming condition ($M = 30.3$, $SD = 21.5$); $t(78) = -1.37$, $p = 0.175$. When analyzing the first 6 spanning times while separating analysis of the naming condition and the non-naming condition, the second mean spanning time was the greatest spanning time in the naming condition, and the second mean spanning time was not the greatest spanning time in the non-naming condition. Analysis of the second mean spanning time compared to all other spanning times was not tested to determine a significant difference when excluding the latter 6 trials.

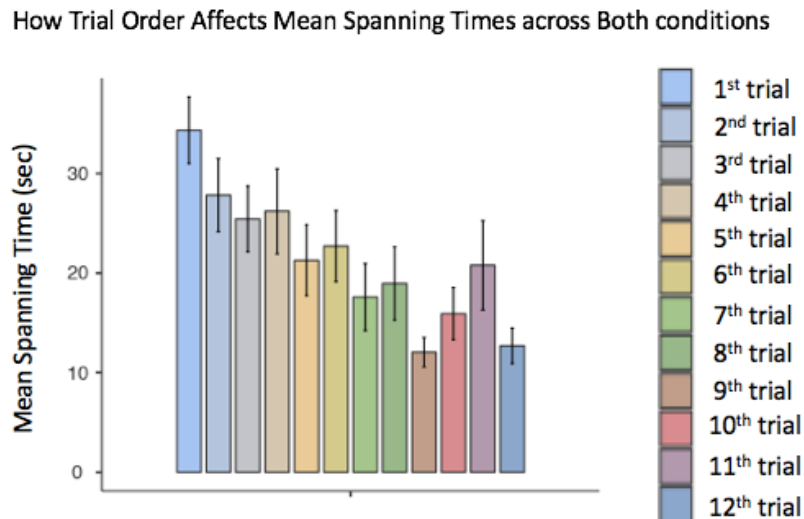


Figure 8. A fatigue effect was found when analyzing the mean spanning times across both the naming and non-naming conditions, or across all twelve trials, that a subject participates in (as opposed to just one condition)

How Condition Affects Mean Spanning Time for the First six trials

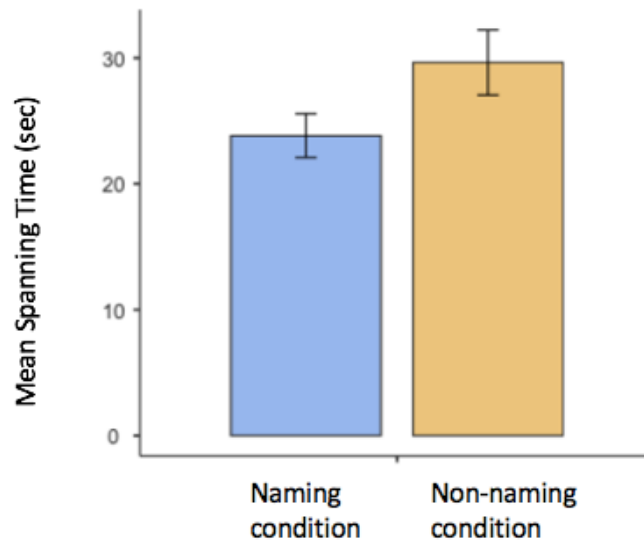


Figure 9. Although the mean spanning time for the naming condition is 5.7 seconds less than the mean spanning of the non-naming condition, the mean spanning times for the naming condition and non-naming condition, when excluding the latter 6 trials across both conditions, were not significantly different

How Trial Order and Condition Affect Mean Spanning Times for the First six trials

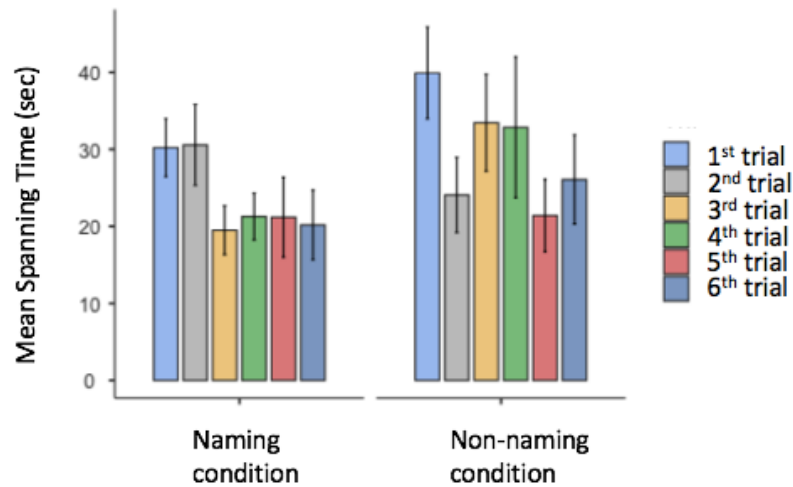


Figure 10. The second mean spanning time is greater than all other five mean spanning times in the naming condition, while the second mean spanning time in the non-naming condition was not greater than all of the other five mean spanning times in the non-naming condition when considering only the first six trials

Discussion

It was assumed that naming a preinventive form would force additional cognitive processing of the current function of the object, which would lead to a heightened difficulty in generating a novel function for the same object. It is known that recent tasks that subjects are engaged with can modulate functional fixedness (Yagolkovskiy & Medevdev, 2019). Specifically, Yagolkovskiy et al. (2019) has shown that naming existing objects that share the same main functional property of a given object to the same extent as the given object may hinder performance on a divergent thinking task. A divergent thinking task is a task that involves multiple solutions to an open-ended problem (Wu et al., 2015). For example, given a wooden

ruler that has a main functional property (e.g., to draw a line), Yagolkovskiy et al. (2019) notes that subjects who wrote down names of objects that shared that same main functional property to a lesser extent as the wooden ruler (e.g., a finger) performed better on a divergent thinking task compared to subjects that named objects with the same main functional property to the same extent (e.g., a book cover). This finding is attributed to a weakening of the strength of the cohesion between the object itself (i.e., the wooden ruler) and its main functional property (i.e., to draw a line). Priming subjects with objects that exhibit a lessened version of the main functional property weakens this cohesion, while priming subjects with objects that exhibit the same version of the main functional property may strengthen this cohesion as seen by performance of generating novel functions for the same object (Yagolkovskiy et al., 2019). This analysis leads to two main assumptions in this study. The first assumption is that subjects in the naming condition will use the function of a given object as context to create a name. By doing so, subjects will be forced to additionally process the current function of the object each time a name is created. The second assumption is that we can apply the analysis of Yagolkovskiy et al. (2019) to this study's naming condition, in which we assume that priming subjects with the main functional property of a given object to the same extent may strengthen the cohesion of the object itself and its main functional property. So, given that subjects process the current function of an object each time a name is created, we assume that the act of naming an object may strengthen the cohesion of the object itself (i.e., the preinventive form) and its main functional property (i.e., the main property of the current function of the object). Creating a name for an object can be likened to naming an existing object with the same main functional property to the same extent, as both manipulations force subjects to

process the main functional property of the given object to the same extent. The act of creative naming forces subjects to process the exact same function as the given object, however this act is still characterized as priming subjects with the same main functional property to the same extent.

This study uses the Search for Ideas Memory Model, as noted by Yagolkovskiy et al. (2019), in which a main functional property serves as a search cue when tasked with generating novel ideas (Nijstad & Stroebe, 2006). Therefore, each novel function a subject generates would serve as a search cue in working memory, which would only select associations that directly relate to the main functional property of the preinventive form. By naming the preinventive form, subjects strengthen their search cue which limits associations only to those associations that are directly related to the current function of the preinventive form. Therefore, by strengthening the search cue, the cohesion between the object itself and its main functional property is strengthened given that the set of associations that can be made onto the preinventive form that are not directly related to its main functional property is lessened.

Our results indicate that there was no significant difference between the mean spanning times for the naming condition and the non-naming condition when taking into account all trials (see Figure 5). A fatigue effect was noted as subjects mean spanning times gradually decreased from the first trial to the twelfth trial (see Figure 8). Since subjects seemed to be less motivated in the last six trials compared to the first six trials, an analysis of the mean spanning times between both conditions was conducted taking into account only the first six trials. However, no significant difference was noted between the mean spanning times for the naming condition and the non-naming condition when taking into account only the first six trials (see

Figure 9). The results of analyzing mean spanning times between both conditions for all trials were not in line with our predictions, as there was not a significant difference between the mean spanning times in the naming condition and the non-naming condition on two levels of analyses. This does not support our fundamental notion that creative naming increases functional fixedness.

However, analyses of the second mean spanning time in comparison to all other mean spanning times suggests that there is potential for the notion that creative naming increases functional fixedness. A revamping of the interpretation of the application of The Search For Ideas Memory Model is necessary for this notion to have potential. Subjects in this experiment are not explicitly told to generate a main functional property for the preinventive form. Given that a search cue is a main functional property in working memory, it is not completely clear as to what search cue subjects are using to select for functions in long-term memory. Despite this lack of clarity, Yagolkovskiy et al. (2019) noted that the weakening of the search cue that lead to improved performance in idea generation due to priming subjects with a weak version of the object's main functional property was ephemeral, in that the improved performance was apparent for only the initial stages of the creative idea generation task. This finding can be applied to the interpretation of the results in this study in that, although analyses related to the mean spanning time do not test for significance, results indicated that the 2nd mean spanning time in the naming condition was the greatest mean spanning time out of all other trials, within one condition and across both conditions, which provides potential support that the main functional property of the first generated function serves as the search cue. The reasoning behind this claim is that, firstly, out of all functions for a subject to use as a search cue, the first

function may serve as the search cue due to it simply being the first generated idea that a subject comes up with in the experiment in direct relation to the preinventive form. In other words, subjects have no association with the preinventive form until they generate the first function, therefore the first function could serve as a good starting point for a search cue.

Secondly, if the first function did serve as the search cue, it would follow that the second generated function in the naming condition would likely exhibit the greatest mean spanning time compared to all other mean spanning times. This is due to the assumption that creative naming strengthens the search cue, and the finding by Yagolkovskiy et al. (2019) that shows how the effect of priming subjects with a weak main functional property resulted in ephemeral improvement of creative idea generation. In this study, if the search cue is taken to be the main functional property of the first function, then the priming of subjects with a strengthened main functional property through creative naming would result in ephemeral poor performance of creative idea generation. This would result in subjects taking the most amount of time to come up with the second function due to the cohesion of the object itself and its main functional property being at its greatest right after the subject performs the first trial. We posit that the ephemeral nature of the strength of this search cue is due to the subjects having to generate a novel function in a novel semantic category, in which the second function is the first function in which subjects must 'break through' the limitations imposed by the search cue. Assuming that the set of associations imposed by the search cue do not include associations that fall within the second semantic category, it follows that subjects will find difficulty in breaking free from the search cue to find a novel function within a novel semantic category. However, when they accomplish this task, the search cue becomes 'weakened', and associations related to a larger

set of semantic categories may be released when subjects generate functions from the third function to the sixth function. This weakening of the search cue may contribute to the fatigue effect found in this study, given that functions generated after the second function may be easier to come up with. This reasoning is not legitimately in line with the results of this study, as, although the results do indicate the second mean spanning time in the naming condition was the greatest mean spanning time, the second mean spanning time was not analyzed to determine if it was significantly greater than other mean spanning times. However, assuming the main functional property of the first function serves as the search cue, then our results show potential for the notion that creative naming increases functional fixedness, while also providing potential support for the anecdotal observation by Finke (1990) that the second function was the most difficult function to come up with. Given that the second mean spanning time was greatest only the naming condition, it follows that creative naming may be necessary for the search cue in the 'spanning paradigm' to be strengthened enough for subjects to find notable difficulty in generating the second function.

The assumption that creative naming increases functional fixedness implies that certain names may increase functional fixedness more than others. This could occur in names that are strongly integrated with the function of the object compared to names that are weakly integrated with the function of the object. However, this study does not judge the names for their strength in relation to its associated function, which could differentially affect mean spanning times. It also should be noted that the practice that subjects were given prior to the experiment may have negatively affected spanning performance. This is due to the practice trial potentially contributing to the fatigue effect found in this study.

Conclusion

There are three main ways to advance this study. In regards to the first direction, the naming condition could have subjects generate two names in association with one function, as opposed to just generating one name. This could result in strengthening the search cue, assuming the search cue is the main functional property of the first generated function, which may result in the 2nd mean spanning time being significantly greater than all other mean spanning times within the condition. In regards to the second direction, a judging system could be devised that judges whether the names of the preinventive forms are strongly connected to their associated function, or weakly connected to their associated function. Novel functions generated after creating a 'strongly associated' name may reflect higher mean spanning times in comparison to that of spans after creating a 'weakly associated' name. This would be due to 'strongly associated' names strengthening the cohesion between the object itself and the main functional property of the object more than that of the 'weakly associated' names. This future study would further elucidate the connection as to how creating a label for an object affects functional fixedness. In regards to the second direction to advance this study, the names could be analyzed to determine if there is a specific process, or processes, that underlie how subjects naturally incorporate the function of an object into a created name. Carroll (1980) has noted that subjects naturally incorporate the context associated with a non-pictorial referent when tasked with creating a name for that referent. This incorporation process is called context incorporation (Carroll, 1980). However, no study has systematically analyzed the process underlying how subjects creatively name objects that have an associated function. A specific incorporation process could occur from the function of the preinventive form to its created

name. Although not systematically analyzed, this study provides support for the notion that subjects naturally incorporate the semantic content of a function of an object when tasked with creating a name for that object (see Appendix D). In conclusion, future studies can adapt this study's paradigm to further our understanding of the anecdotal observation noted by Finke (1990), how differences in the names of objects may modulate functional fixedness, and how there may be underlying processes that we use to naturally create names for objects.

preinventive forms are ideal referents to use in experiments related to Cognitive Science due to their ambiguous nature and their ability to be interpreted in multiple ways (Sternberg et al., 1995). Future research should take advantage of these ideal referents to further our understanding of creative thinking.

Acknowledgements

I would especially like to thank Professor Drew Walker for continuously helping me with my thesis in all of its facets throughout my senior year. You were willing to support my ideas, but challenged me to hone them down into sensible parts. What I enjoyed the most about this project was the continuous intellectual discussion that incrementally furthered the project day by day, and I hope you enjoyed that as much as I did. I would like to thank Michael Allen for helping me with the experimental design and theoretical framework of my thesis throughout my senior year. I would like to thank Professor Taylor Scott for helping me with the experimental design. I would like to thank Professor Ed Vul for letting me conduct the experiment in his laboratory. I would like to thank Danielle Dun for helping me with randomizing the presentation of conditions and trials in the experiment. I would like to thank

Paul Goo for giving me feedback in the initial stages of the experimental design. Finally, I would like to thank Talia Preis for cross-checking the accuracy of the data.

References

Carroll, J. M. "Creating names for things." *Journal of Psycholinguistic Research*. Vol. 10, 1981, pp. 441-455

Duncker, Karl. "On Problem-Solving." *Psychological monographs*, 58, 1945, pp. 1-113.

Finke, Ronald A. "Creative Imagery: Discoveries and Inventions in Visualization." Lawrence Erlbaum Associated, 1990.

Glucksberg, S., & Danks, J. H. "Effects of discriminative labels and of nonsense labels upon availability of novel function." *Journal of Verbal Learning and Verbal Behavior*. Vol 7. 1, 1968, p. 72-76.

Nijstad, B., Stroebe, W. "How the group affects the mind: a cognitive model of idea generation in groups." *Personality and Social Psychology Review*. vol. 10, no. 3, 2006, pp. 186-213.

Sternberg, R., Davidson, J. "The nature of insight." The MIT Press. 1995, pp. 255-278.

Wu, X., Yang, W., Tong, D., Sun, J., Chen, Q., Wei, D., Zhang, Q., Zhang, M. and Qiu, J. "A meta-analysis of neuroimaging studies on divergent thinking using activation likelihood estimation." *Human Brain Mapping*, vol. 36, no. 7, 2015, pp. 2703-2718.

Yagolkovskiy, S. R., & Medvedev, B. P. "Enhancement of Creativity: Semantic Priming Through Naming Objects Loosens Functional Fixedness within Idea Generation." *Journal of*

Creative Behavior, 2019.

Appendix A

List of Rules

1. You must use all three of the object parts given to you
2. You can change, using your imagination,
 - a. the size, position, or orientation of any object part
 - b. the solidity of any object part (they can be solid or hollow, open or closed)
3. You cannot change, using your imagination, the shape of the object parts (except for one object part that will be noted upon presentation)
4. You can attach the object parts in any way (one object part can even be put inside of another object part)
5. Aim to form a combined object of a potentially practical use (function)

Appendix B

Base Form

(draw in the allotted space below)

A large, empty rectangular box with a thin black border, occupying the majority of the page below the text. It is intended for a drawing or sketch.

Appendix C



The rules for mentally assembling are that:

1. You must use all three of the object parts given to you
2. You can change, using your imagination,
 - a. the size, position, or orientation of any object part
 - b. the solidity of any object part (they can be solid or hollow, open or closed)
3. You cannot change, using your imagination, the shape of the object parts (except for one object part that will be noted upon presentation)
4. You can attach the object parts in any way (one object part can even be put inside of another object part)
5. Aim to form a combined object of a potentially practical use (function)

Base Form

(draw in the allotted space below)

The combined object you just created is called a 'Base Form'. Now that you have created your 'Base Form', you must imagine a function for this object within a given category.

When attributing a new function, you can manipulate, using your imagination:

- a. the size, position, or orientation of the 'Base Form' you just sketched
- b. the solidity of the object parts (they can be solid or hollow, open or closed)
- c. the composition of the object parts (e.g. wood, metal, rubber, glass, or any combination of these materials)

Think of a function for your 'Base Form' that fits within the category of **Personal Items**

Also, you must use the original, non-manipulated 'Base Form' you just sketched on the "Base Form" handout as the basis off which you attribute a new function for each trial (not any manipulated version of the 'Base Form' from a previous trial)

Think of a function for your 'Base Form' that fits within the category of **Appliances**

Appendix D

Function: "It would transport UV light rays to an object"; Name: "Light to Life"; Superordinate category: Transportation

Function: "... the curved top and the bottom base of the base form can be made of magnet material... the curved top of the base form is a weaker magnet and can attract small objects such as pins and needles while the bottom base is made of a stronger magnet and thus, can attract much larger object such as metallic pens or... screws"; Name: "The Magical Magnet"; Superordinate category: Tools & Utensils

Function: "As users step into the hallow circle and are placed under water, the loop flails from side-to-side (acting as a fin) and the users guide their direction into the depths"; Name: "Water Skormer"; Superordinate category: Transportation

Figure 8. Functions and names generated from a Preinventive Form created from Object Part A

Function: "The person could sit in the cone and hold onto the line above, the bottom would bounce like a spring and they would hop around from place to place"; Name: "Hoppatron"; Superordinate category: Toys & Games

Function: "The hollow triangular shape could serve as a housing containment for lab specimen"; Name: "Hanging Biome"; Superordinate category: Scientific Instruments

Function: "Children can hold onto the triangular base and swing around together"; Name: "Giant Swing"; Superordinate category: Toys & Games

Figure 9. Functions and names generated from a Preinventive Form created from Object Part B