DO MOTOR ACTIONS INFLUENCE CREATIVE COGNITION? A REPLICATION OF FRIEDMAN AND FÖRSTER (2002)

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Abstract

From artistic endeavors to evolutionary survival skills, creativity influences various aspects of everyday life. Previous research has shown that numerous factors influence an individual's level of creativity, from mood to nonaffective motor movements. Based on existing literature suggesting certain motor actions can influence mental states, such as approach or avoidance mindsets, Friedman and Förster (2002) examined the effects of arm movements (arm flexion and extension) on creativity. Their study has provided the basis for much research in recent years, thus making it imperative to better understand the initial results found by Friedman and Förster. We replicated their Experiment 2 by similarly manipulating arm movements and examining participants' creativity. In contrast to the findings of Friedman and Förster's original study, overall, arm movements did not influence creativity in our study. Though some potential limiting factors could be addressed in follow-up research, it is significant to note that the relationship between motor actions and creativity may not be as well-defined as previously thought.

Do Motor Actions Influence Creative Cognition? A Replication of Friedman and Förster (2002)

Creativity is far from novel and among some of the most widely acknowledged constructs in modern society; most would say it pervades everyday life. A significant function for human longevity, especially evolutionarily, creativity has played a fundamental role in compensating for human deficiencies. As humans are not equipped with physical mechanisms to avoid danger, such as being able to outrun potential nonhuman predators or naturally camouflaging themselves with their environment, creativity emerges as a means to fill the gap, thus making creativity crucial to leading a prosperous life, and even to maximize survival itself (Baas, De Dreu, & Nijstad, 2008). Given that creativity is so intrinsically and fundamentally important to an individual's prosperity, it follows that understanding factors that influence creativity is of utmost importance as well.

While Amabile (1996) defines creativity as an ability to generate novel and conceivably useful ideas, insights, and solutions to various problems, others define creativity differently. Sternberg (2016), for example, asserts creativity can stem from an attitude one adopts in approaching basic life and work scenarios, with cognitive, affective, and motivational elements all contributing. These factors, such as mood, differ across individuals to account for varying individual levels of creativity. Thus, by definition, creativity is a unique concept and can differ vastly across individuals. Measured in a variety of situations from problem solving tasks to idea generation tasks, there are many ways in which to define an individual's level of creativity (Baas et al., 2008). Creativity, this adaptation and ability to find new solutions to changing circumstances, manifests itself in varying extents across the population and it has become a popular focus of research within psychology, with particular attention being given to areas such as social and cognitive psychology (Baas et al., 2008).

Although some people are more creative than others, there are a variety of situational factors that might influence a person's creativity. From conventional factors to the more foreign and unexpected, a diverse range of influences all play varying roles. Many of these factors can be classified as nonaffective factors, or those which do not affect mood. For example, Leung and colleagues (2012) suggest a link between bodily experiences and creativity. Following from the metaphor of "thinking outside the box", which presumably encourages a person to think more creatively, participants who completed a creative problem solving task while physically sitting outside a box performed better than those who sat inside a box. Manipulating the body without affecting mood, this measure and the ensuing results evidence the fact that nonaffective factors play a role in creativity.

Furthermore, affective cues, those which do influence mood, are also known to have an impact on people's level of creativity. Several factors contributing to the overall concept of mood play a role in an individual's mood in any given circumstances and many studies have looked at said factors (Baas et al., 2008). One of which, hedonic tone (the extent to which a mood state is positive or negative), is particularly useful in understanding the relationship between mood and creativity. Generally, positive affect can bolster creative ways to solve problems compared to negative or neutral affect, as people who are in a good mood tend to be more creative than people in a bad mood (Clore, Schwarz, & Conway, 1994; Friedman & Förster, 2002; Schwarz & Bless, 1991). One example of this is exemplified by Clobert, Van Cappellen, Bourdon, and Cohen (2016): participant emotions were manipulated via the reading of a positive astrological forecast (horoscope); those who read a positive horoscope had increased cognitive functioning and performed more creatively compared to participants who read a negative horoscope. An additional aspect of mood stems from activation state, a distinction between activating and deactivating moods. Deactivating moods (e.g., sadness) are those associated with neutrality and relaxation, while activating moods (e.g., anger) are associated with actions, such as preventing or promoting a particular thing. Across the two, activating moods are correlated with increased creativity (Baas, De Dreu, & Nijstad, 2011). A third component upon which mood states can vary is that of regulatory focus, a subset of activation state focused on the distinction between prevention versus promotion activation states. The two differ in that prevention activation states are those associated with the avoidance or something negative, whereas promotion states are those associated with the promotion of something beneficial, each of which are dependent on one's environment (Baas, De Dreu, & Nijstad, 2011). While hedonic tone and activation state have been given more meaningful consideration in psychological research, regulatory focus is a relatively new construct in research and, as such, less attention has been devoted to the understanding of the manipulation of regulatory focus and its impact on creativity. With each dimension working together to influence mood, an understanding of all three is necessary for greater comprehension of the link between overall mood and creativity itself.

One explanation behind why mood can play a role in creativity is that of cognitive tuning, which alerts an individual as to the nature of their surroundings (Schwarz & Bless, 1991). When people are in a positive mood, it alerts them that their surroundings are safe. According to Schwarz and Bless, this would lead people to be more willing to take risks and be more comfortable with uncertainty. This aligns with the promotion mindset of regulatory focus: individuals in a good mood have no immediate threats in their environment and, thus, will be more interested in the promotion of something beneficial, rather than prevention of a negative event. In contrast, being in a negative mood alerts people that there is something wrong with their current situation. This would lead people to be less willing to take risks and to seek out certainty, adopting a prevention-based mindset, as they are likely to attempt to prevent or minimize a dangerous situation. According to the cognitive tuning theory, negative moods should lead people to adopt viable plans of action that are readily accessible, rather than investigate numerous solutions to problems, thus decreasing originality. In short, the cognitive tuning explanation rests on the notion that a person's mood influences their processing style—positive moods leading to approach-oriented styles and negative moods associated with avoidance-oriented styles.

Affective states can influence a person's processing style; however, non-affective bodily states can also influence a person's processing style. For example, Cacioppo, Preister, and Berntson (1993) contend that arm flexion is regularly associated with the notion of beckoning a desirable person towards one or accumulating a desired object. Arm extension, however, is related to the theoretical notion of avoidance motivation and the evasion of undesired objects. In other words, an individual learns to associate arm extension with the renouncement of unwanted objects. Arm extension thus stimulates avoidance motivation whereas arm flexion stimulates approach motivation.

Furthermore, nonaffective cues (e.g., motor movements) are also related to creativity: specifically, arm flexion and extension can increase and decrease creative problem solving, respectively (Friedman & Förster, 2002). Closer look with respect to the cognitive tuning theory can help explain this phenomenon. When people engage in arm flexion, this activates approach motivation, which signals a benign environment causing people to be willing to take risks and increase tolerance of uncertainty. When people engage in arm extension, this activates avoidance motivation, which signals a threatening environment causing people to be less willing to take risk and decreases tolerance of uncertainty. To test this idea, Friedman and Förster (2002) had participants engage in either arm flexion (placing one arm under a table and applying light pressure) or extension (placing one arm palm down on a table and applying light pressure). In a series of experiments, Friedman and Förster (2002) issued various tasks assessing creativity after manipulation of the arm flexion and extension motor actions. Aligning with initial hypotheses, they found that arm flexion increased creativity relative to arm extension. This pattern held even while controlling for outside factors such as mood and enjoyment and perceived effort of the task.

Given this body of literature and the known variations in factors which can influence creativity, it becomes apparent the need to understand whether it is regulatory focus that matters, or something else. Existing literature has established a link between mood and creativity; though this link is assumed to operate via regulatory focus, no prior studies manipulate regulatory focus (prevention vs. promotion mindsets) and look at the effects on creativity. By using an established motor action manipulation known to evoke prevention/promotion mindsets, Friedman and Förster (2002) investigated the mechanism in which mood is suggested to affect creativity, hoping to understand better the relationship between the two. Manipulating mindset without influencing mood, motor actions can help to answer whether nonaffective factors can truly influence creativity.

The current study replicated Friedman and Förster's (2002) Experiment 2 in which participants were asked to engage in either arm flexion or extension in order to evoke a promotion or prevention motivation with regard to problem solving approaches. Upon completion of a creative generation task in which participants produced novel responses, responses were rated with regard to creativity and assessed overall for patterns regarding manipulated focus state and level of creativity. Given the results of the work of Friedman and Förster (2002), the necessity for replication becomes apparent for several reasons. Namely, the study has not been previously replicated and, in order to be confident that motor actions do in fact influence creativity, a replication is necessary. Additionally, subsequent research has based theoretical explanations for mood and its effects on creativity on this initial study (Baas et al., 2008). Should results fail to replicate and the real relationship differ from previous assumptions based on the original study, it becomes problematic that other research is founded on this study. Ensuring that the effect replicates is important in laying a proper foundation for follow up studies and those building upon it. Another factor motivating this replication is that the original Experiment 2 had a mere 26 participants in it, raising concerns as to its true validity. For more generalizable results in order to better understand how motor movements affect most people and the way in which they respond, a larger sample size is required. Finally, it is worth noting that, recently, replications were completed for 100 existing psychological studies, with only 36% of replications showing statistically significant effects, compared to the 97% of original studies (The Open Science Collaboration, 2015). Data such as these further substantiate a need for replication of Friedman and Förster's (2002) research.

Should data reflect the findings of Friedman and Förster (2002), greater confidence and reliability will be lent to their study. In the case that data replicates their findings, one can conclude that different states bolstering or inhibiting creativity can be induced with certain motor movements. Additionally, as a result of other, outside variables potentially influencing creativity, increased certainty as to the nature of the relationship between motor actions and creativity without outside interaction or influence from simultaneous manipulation of mood will be obtained. Given the universality and significance of creativity to human survival and prosperity, such findings can then be applied and practiced in everyday life. Furthermore, findings of the proposed study will have great implications on various other studies which have been proposed and/or completed based on Friedman and Förster's (2002) findings. Data reproducing that of the original study will reinforce the ability of other studies to draw conclusions and perform additional research applying and extending Friedman and Förster's (2002) findings. Should the study find data contradictive to the original study, however, the validity of various other works based upon their initial findings may be called into question.

Method

Participants

A total of 127 undergraduate students from Appalachian State University were recruited through the Psychology Department Subject pool (SONA) for an experiment regarding "hemispheric activation". One participant was dropped from the study due to their conversing with the research assistant while completing the creativity task, leaving a final sample of 126 participants (61.7% women, 38.3% men, M_{age} = 23.34, SD_{age} = 3.46). Participants were provided course credit and candy for participation.

Procedure

Following arrival to the lab, participants were seated at a computer workstation and given a brief statement on the purpose of the research study, the risks, an explanation that participation was voluntary, and contact information for experimenters. After agreeing to participate, participants were then told that they were participating in a study examining the relationship between left and right brain activation and problem solving. Reasoning as to why they would be asked to perform certain motor actions was given via the following cover story, previously used by Friedman and Förster (2002):

> "Today, you'll be participating in a study examining the effects of hemispheric lateralization on problem solving. More specifically, we're trying to understand the relationship between left and right brain activation and the ability to solve certain types of problems. Basically, there's been an ongoing debate, with some people saying that the left hemisphere is the center for this type of cognitive activity and others saying that the right hemisphere is more critical. You have been randomly assigned to the left hemisphere activation condition. The standard way in which this hemisphere is activated is by having participants assume a particular right arm position."

All participants were told that they had been randomly assigned to the left hemisphere activation condition and that the standard way this hemisphere is activated is by having them assume a particular right arm position. Participants were randomly assigned to one of two motor action conditions: arm flexion or arm extension. Upon giving the participant the cover story, the research assistant (who was blind to the hypothesis) then demonstrated the appropriate arm motion on the computer workstation table by pressing his or her right palm lightly upward against the bottom of the table with the elbow bent at a right angle (arm flexion) or by pressing his or her right palm lightly downward against the top of the table with the elbow straight (arm extension). The participants were then asked to demonstrate their assigned motor action to ensure correct performance. Next, participants completed a questionnaire assessing their current mood and anticipated task enjoyment to rule out the possibility of mood or interest as mediating variables. Particularly, participants were asked "How do you feel right now?" on a scale of 1 (*very bad*) to 9 (*very good*) and "How much do you think you would enjoy the task?" on a scale of 1 (*I would not enjoy it at all*) to 9 (*I would enjoy it very much*).

Subsequently, the participant was instructed to put on headphones and listen to further instructions regarding the experiment task. Specifically, the audio-recorded instructions told participants:

> "In this part of the experiment, you will have one minute to generate as many creative uses for a brick as you can think of. Refrain from listing typical uses or uses which are virtually

> impossible. After one minute has passed, you will be told to stop generating uses, discontinue your motor action, and fill out a final questionnaire."

Participants then had exactly one minute to generate as many creative uses for a brick as possible. While doing so, participants engaged in their assigned motor action. In order to allow engagement in the appropriate motor action, participants gave their answers verbally into a mouthpiece attached to the headphones, which were then recorded as an audio file. After precisely one minute, participants were asked to cease generating creative uses and discontinue their motor action. Lastly, participants completed a post-task questionnaire assessing current mood ["How do you feel right now?" on a scale of 1 (*very bad*) to 9 (*very good*)], enjoyment of the task ["How much did you enjoy the task?" on a scale of 1 (*not at all difficult*) to 9 (*very difficult*)], pleasantness of the motor action ["How pleasant was the arm position?" on a scale of 1 (*not at all pleasant*) to 9 (*very pleasant*)], effortfulness of the motor action ["How effortful was it to maintain the arm position?" on a scale of 1 (*not at all effortful*) to 9 (*very effortful*)], and handedness ["Which hand do you use most for everyday tasks?" with response choices: Right hand, Left hand, and I use both hands equally]. Participants also answered demographic questions regarding age and gender. Finally, participants were asked what they thought the purpose of the study was. Upon completion of all post-task questionnaires, participants were given course credit and candy and thanked for their participation.

Data Coding

Responses were audio recorded for each participant upon generation in the lab and saved temporarily on the computer server. Upon completion of data collection, each recording was transcribed by a research assistant who was blind to the participants' conditions and the study hypotheses. All 731 uses were compiled into one list, randomized, and distributed to 10 research assistants who were blind to conditions and the hypotheses of the study. The research assistants were trained on how to rate the responses by reading the “Data coding” description in Friedman and Förster’s (2002) original study. Scorers were also shown a sample of 10 uses in order for them to have an idea as to the range of responses they would encounter. They were not, however, told a specific value that the 10 uses should be given. The scorers rated each individual use on a 9-point scale, answering the question, “How creative is this response?”, from 1 (*very uncreative*) to 9 (*very creative*).

After the uses were rated by the research assistants, consistent with Friedman and Förster’s (2002), three variables were calculated: the total number of uses per participant, an average creativity score for each participant (calculated by totaling the creativity ratings for each use generated and dividing by the total number of uses generated), and the total number of creative uses for each participant (those which exceeded a midpoint rating of 5 on the scale).

Results

A total of 126 participants completed the creative generation task and supplementary measures. Friedman and Förster (2002) conducted three primary analyses, each of which we conducted as well for the present study. These primary analyses specifically included: comparison across arm flexion and arm extension conditions on the total number of uses, the average creativity rating, and the total number of creative uses (i.e., the number of uses given a rating of “5” or higher. Friedman and Förster (2002) found that the total number of uses was unaffected by motor action, but the motor action did influence the average creativity rating and the total number of creative uses.

The first analysis we conducted compared the total uses generated by participants across arm flexion and extension conditions. An independent samples t-test revealed that there was not a significant difference in the total number of uses generated by participants in the flexion (*M*=

5.68, *SD* = 2.33) and extension (*M* = 5.92, *SD* = 2.45) conditions, $t(124) = .56$, $p = .28$, $d = .10$ (see Figure 1). This finding is consistent with the study conducted by Friedman and Förster (2002). Next, we conducted an independent samples t-test comparing the average creativity ratings across conditions and found no significant difference in the average creativity rating for participants in the arm flexion (*M*= 2.96, *SD* = 0.68) versus arm extension (*M*= 3.15, *SD* = 0.75) conditions, $t(124) = 1.49$, $p = .45$, $d = .06$ (see Figure 2). Our findings are not consistent with Friedman and Förster (2002), as they found a significant difference. Finally, we conducted an independent samples t-test comparing the total number of creative uses across conditions and found no significant difference in the total number of creative uses across arm flexion (*M*= 0.46, *SD* = 0.76) and arm extension (*M*= 0.65, *SD* = 0.92) conditions, $t(124) = 1.27$, $p = .42$, $d = .05$ (see Figure 3). These findings are also not consistent with Friedman and Förster (2002), as they found a significant difference.

Exploratory Analyses

Additionally, we ran a few other measures controlling for pre- and post-task mood and enjoyment, task difficulty, and pleasantness and effortfulness of the motor action, as well as assessing factors such as handedness, gender, age, and prior completion of task, all of which support a lack of main effect across arm flexion and extension conditions.

Overall, the results contradict the original hypothesis and previous findings of Friedman and Förster (2002), failing to demonstrate a significant difference across motor action conditions. Arm flexion, the nonaffective motor movement associated with positive internal cues, did not lead to more total responses, nor more creative mean responses compared to arm extension, which is associated with negative hedonic states.

Discussion

Aligning with Friedman and Förster's (2002) initial study, we hypothesized that nonaffective motor actions serving as bodily cues associated with positive or negative hedonic states would influence creativity. In relation to the cognitive tuning theory, arm extension was expected to elicit risk-aversive mental cues, while arm flexion would evoke mental states associated with positive, exploratory cues. Specifically, arm flexion, relative to arm extension, was expected to bolster creativity in participant responses for creative uses for a brick.

These predictions were not supported by the results of the current study. There was no effect across arm flexion and extension conditions, with no significant differences on total number of responses, mean creativity scores, or total number of creative responses. Alternative explanations were examined in exploratory analyses, further determining no effect across arm flexion and extension conditions when controlling for variables such as age, gender, pre- and post-task mood.

There are a number of possible explanation for why the current study failed to find a difference between the arm flexion and arm extension conditions revolving around differences between the current study and the study conducted by Friedman and Förster (2002). One notable difference in the present results was that participant responses were particularly uncreative in general, especially in comparison to original study. While Friedman and Förster found the average number of creative uses to be 4.08 and 2.38 for arm flexion and extension, respectively, our study found averages of 0.46 and 0.65, respectively. These findings could reflect less creativity across the board in our study. Should a certain amount of creativity be necessary in order to see effects, this could explain why our results failed to show significant differences across conditions. Had we seen a greater degree of creativity overall, a significant effect for differences across the motor action conditions may have been present. A particularly poignant factor which may have affected this could lie in the fact that the original study was done in Germany, while our replication was completed in the United States. Perhaps more creative than Americans, a German sample could skew results should this be the case. If Americans are, in fact, less creative in general than Germans, any significant effects could have been masked due to low baseline levels of creativity, with any increases caused by an arm flexion manipulation being easily masked.

Another explanation for a lack of significant effect could be that people were already familiar with task, thus influencing creativity. In order to control for this, however, participants were asked if they had completed the generation task for creative uses of a brick prior to participation in this study and in the exploratory analyses those participants were dropped from analyses. After excluding those who had encountered the task previously, there was still no significant effect, making this an unlikely alternative explanation.

Additionally, the present study replicated one particular experiment within a series of studies in Friedman and Förster's (2002) original work. Should we have replicated each experiment, it is possible that similar effects would have been found across all of them, with this particular experiment being an outlier. While there is no way of determining if this is the case for the particular replication performed, future experiments should address this and could encompass additional experiments from the initial study.

Despite noted limitations and potential variables and explanations above, it is worth noting that the effects found in the original study may not hold particularly true or reflect actual trends outside the original lab setting. While present in Friedman and Förster's (2002) original work, no significant effects were present in any of the three analyses on the variables examined.

Not only were significant effects absent, but differences across conditions were far from being significant, raising doubts as to whether the original results would replicate even if all other variables were accounted for. In the current study, the sample size was greatly increased relative to the original study (126 vs. 26), so the current results might be a more accurate representation of how motor actions influence creativity in most people. However, at this point, we cannot say which – if either – of the original or present studies are flawed in their findings. Therefore, it would be inappropriate to take either at face value, especially the original. With none of the effects replicating, one should be aware that the effect may not be present in all situations or environments, and adjust future research accordingly.

Conclusion

Despite finding no significant effects on total number of uses, mean creativity, or total number of creative uses across arm flexion and extension conditions, the results of the present study are far from conclusive. While certainly not providing support for the original effects of Friedman and Förster (2002), we cannot definitely say that their findings are incorrect or nonexistent. As previously mentioned, future research could address limitations of the present study (e.g., completion of only one of the experiments in the original study, or a sample of solely Americans) to further determine the relationship between motor actions and creativity. More work is necessary in order to get a better picture of the true nature of the relationship between motor actions and their effects on mood, which influence creativity. At the very least, given the findings of the Open Science Collaboration (2015) which shed light on a potential problem with the inability of some research to replicate, however, our study serves to reinforce the fact that not all psychological studies replicate and original findings should be taken with a grain of salt, so to speak. Many studies which are never replicated are not awarded this consideration, with

Friedman and Förster's being one of such works, as many people have cited their findings as though they were fact, despite a lack of replication since original publishing.

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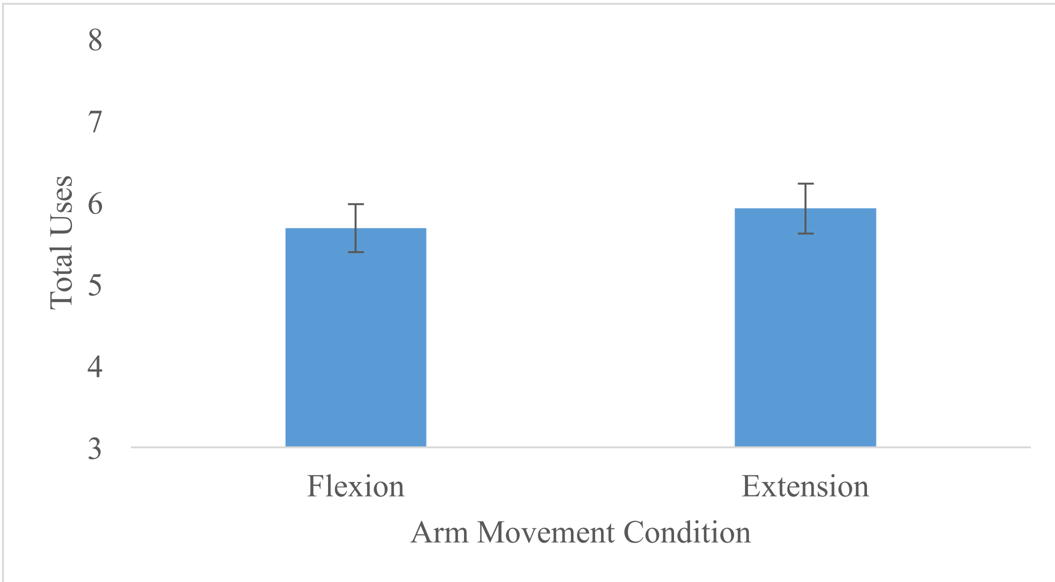

Figure 1. Total number of uses for brick across arm movement conditions.

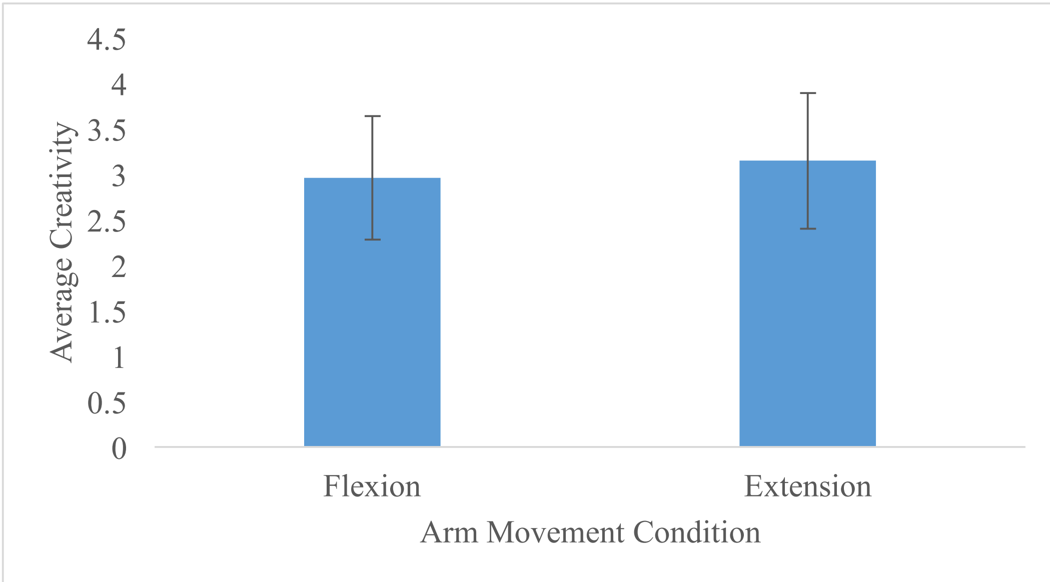

Figure 2. Average creativity ratings across arm movement conditions.

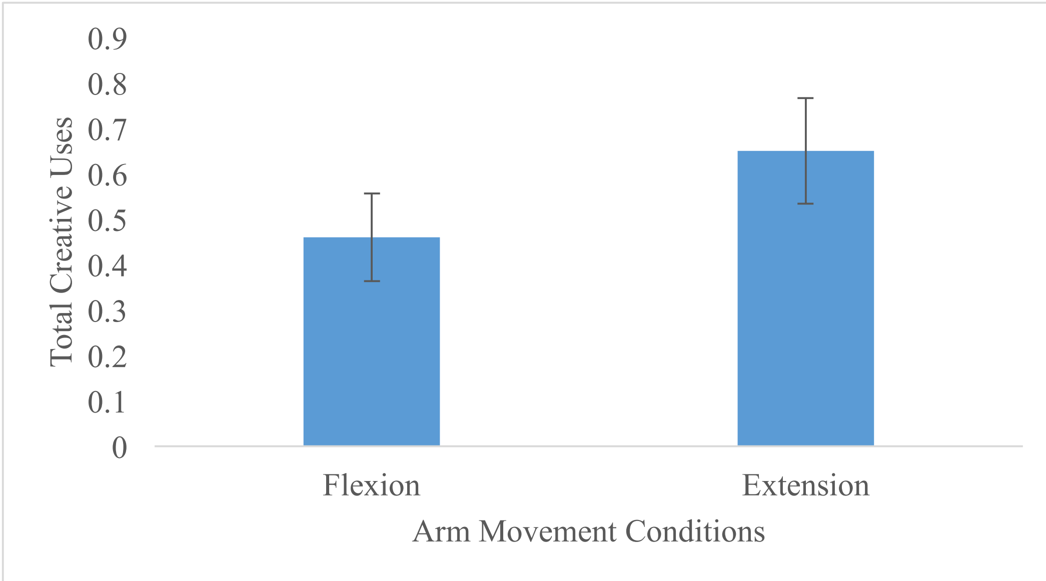

Figure 3. Total creative uses (those rated above the midpoint, "5") across arm movement conditions.