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Shock and Awe: Surprising Revelations on Cognition

Jacob Martin
Western Oregon University

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Surprising Revelations on Cognition

By

Jacob T. Martin

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Dr. Debi Brannan,
Thesis Advisor

Dr. Gavin Keulks,
Honors Program Director

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Abstract

Surprise is a fundamental, yet by definition unpredictable element of life. In the current experiment, the aim is to explore if surprise will have some form of statistically significant effect on cognitive performance. Participants consisted of 7 students from a northwestern university, the average age of participants was 19.3 (S = .756). Materials include a Hexbug Fire Ant remote controlled robot, two tests of cognitive ability, a demographics form, a debriefing form, and an informed consent form. Participants first read and signed the informed consent. The robot was kept out of sight of participants. Subjects completed two tests with the pen on the desk. In the experimental group, the robot would suddenly be wheeled out from its hidden location before taking the test. After, subjects completed the demographics form and were debriefed. Participants were scored on the number of questions answered correctly. Participants who did receive a surprise had a slightly higher score (M = 17.25, SD = .5) than individuals who did not (M = 15.33, SD = 2.52). The mean difference was not significant, $t(5) = .186$, $p > .05$, d = 0.511. The results do not support the hypothesis. This suggests that the treatment had no effect on participants. However, this study had multiple limitations.

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Surprise is a fundamental, yet by definition unpredictable element of life. These sudden, unexpected events are even biologically programmed to have a response in humans, as anyone who has reflexively flinched can attest. Even if someone claims to never have been surprised, chances are they have been startled by something, such as a sudden loud noise or an unexpected static shock. As a matter of fact, being surprised and being scared by something are the same biological state, being a short-lived version of the fight-or-flight response associated with fear.

Knowing that surprise can have this effect on the body, how does it affect the mind? Regrettably, there is not much research in this specific area. However, there are some examples. One such effect, though questioned, is flashbulb memorization. A study explains it as flashbulb memories are detailed memories stored on a single occasion, usually associated with a significant event such as important life changes, and kept for a significant period of time (Vallet, Manzanero, Aróztegui, & García Zurdo, 2017). One commonly used, though starting to get dated, example of this is an individual's memory of where they were and what they were doing on 9/11. In addition, there is the fight-or-flight state, as mentioned earlier. This state prepares the body for acting first and thinking later, which could lead to mistakes while affected by fear. This also has the effect of making a person tired should it be maintained for a long time, which reduces a person's cognitive ability as well. Both of these features can be explained evolutionarily, as in dangerous situations it is important to act quickly and with as much physical capability as possible. Meanwhile the flashbulb memorization allows the individual to remember details about the event, such as how the event started, so that they can potentially avoid it

in the future. One last concept that helps explain surprise, rather than its effects, is the schema. A schema is a mental representation of how a thing normally is. For example, a professor's office typically has a chair, a desk, and some books. This is expected in all situations until enough events break this schema (the breaking of schema, and therefore the automatic assumption, being surprise), as it is proven by experience that the old schema needs to be adjusted.

Deng, Chang, Yang, Huo, and Zhou (2016) performed an experiment on general emotions. While there are gender differences in emotional responses to specific emotions, researchers have found that this is not the case for the polarity of the emotion although women report more intense responses. More specifically, their does not support the stereotype that women are more emotional than men. Men have more powerful experience, and women are more expressive. Moreover, this suggests that gender will likely have little effect on the differences produced by surprise, as surprise is just a specific emotion, and this study found no difference between men and women in emotion in general.

In other work by Arnaudova, Krypotos, Effting, Kindt, and Beckers (2017) focused on anxiety. More specifically, the researchers found that overgeneralization of stimuli did not occur in those at risk of anxiety disorders, but rather those who already have the disorder, suggesting that the anxiety disorder is likely the predictor. Overgeneralization is likely a trait of full-on anxiety disorders, and is not a potential cause for that type of disorder. Additionally, Gazendam and Kindt (2012) also performed research regarding anxiety, specifically the link between worrying and anxiety. The researchers found that worrying results in increased fear responses to feared stimulus and

original safe stimulus and hindered unlearning of conditioned fear, therefore worry may contribute to anxiety disorders. This suggests that it may be a good idea to keep the participants calm and unaware before the experiment begins, such that they do not fear the upcoming surprise.

A pair of psychology professors, Schützwohl and Reisenzein (1999), performed research on schemas, response time, and age. Children and the elderly respond to schema-discrepant events (i.e., surprises) after a longer delay than young adults, and this delay is significantly longer than with schema-consistent events. This was believed to be due to differences in processing efficiency, rather than different processing methods. The ability of the surprise to be explained can have a large effect on this delay. Doing research alone, Schützwohl (1998) conducted an experiment involving schemas and response time. Response times to schema-discrepant events were found to increase with schema strength, but memory for the event was not affected by schema strength. Self-reports of surprise are vulnerable to memory distortions, which may have been caused by hindsight bias. Next, Schützwohl and Borgstedt (2005) uncovered that during surprise, unpleasant stimuli were given more attention than otherwise, along with faster decisions which can be linked to evolutionary psychological theories. Similarly, Meyer, Reisenzein, and Schützwohl (1997) found that a surprising change in a focus stimulus increased reaction time, compared to similar change in distractor stimulus. This effect diminished on repetition.

Flashbulb memorization is associated with observation of surprise events and enhanced memorization of information related to those events. A study by Kock, Chatelain-Jardón, and Carmona (2009) examined how surprise can activate flashbulb

memorization. The hypotheses posed by the researchers were that knowledge retention for modules 3 (before surprise) and 4 (after surprise) will be higher in a treatment group, compared to the control. The third hypothesis was that the other modules (1, 2, 5, and 6) will not be affected in either condition. The independent variable was whether or not the subjects received a surprise between modules 3 and 4, with the dependent variable being how much the subjects learned around those modules (both 3 and 4). The independent variable was manipulated by having a screen with an image of a snake ready to strike inserted between modules 3 and 4. Subjects completed a test after finishing the modules, serving as a measure for the dependent variable. The researchers found that all three hypotheses were supported. The researchers further suggest a use for their results, being that surprise could be used in training for emergency situations by incorporating surprise; training would be significantly more effective and require less repetition.

In the current experiment, the aim is to explore any potential link between surprise and cognitive performance. In particular, the expectation is that surprise will have some form of statistically significant effect on cognitive performance due to the multitude of effects it has. This is due to the flashbulb memorization research mentioned above (increasing learning when exposed to surprise) and the fact that the surprise will not be long-term, avoiding the majority of negative effects from the fight-or-flight state may cause. This will be tested with a between-subjects experiment, involving a control and an experimental group. The experimental group will receive a surprise, and both groups will perform the same cognitive test to determine the effect, if any, of the surprise. The independent variable in this study is a surprise, and the dependent variable is how well the subjects perform on a test of cognitive ability.

Method

Participants

Participants consisted of 7 students from a northwestern university, with all 7 participants female, the average age of participants was 19.3 (S = .756) and age ranged from 18 - 20. Participants were randomly assigned into either the control or experimental group, with 3 in the control and 4 in the experimental group. Most of the participants were psychology majors or minors. Participants were recruited through the SONA system and word-of-mouth. Participants were compensated with extra credit for courses through SONA when applicable.

Materials

Materials include a small remote controlled robot and its remote, two tests of cognitive ability, a demographics form, a debriefing form, and an informed consent form, all of which were approved by the IRB Board at WOU. The experiment took place in a neutral room in the campus library.

A Hexbug brand “Fire Ant” remote controlled robot (HEXBUG 2019) was used to form the experimental condition. This robot moves fairly quickly, and is rather small, allowing it to be concealed and quickly revealed. Additionally, the remote is also small, allowing it to be held without participants noticing.

The informed consent form was used to obtain consent from participants before the experiment began. The form was additionally used to screen for individuals with pacemakers or similar devices. The form explained that the experiment was a test of cognitive ability, but does not mention that surprise will be a factor or that the robot will be used, in order to preserve the surprise.

The two tests of cognitive ability have ten questions each. Both feature different types of questions meant to assess cognitive ability along the lines of an IQ test. The scores obtained from the tests were entered into the SPSS statistical analysis program to determine if there was any significant difference between the control and experimental groups. The CogAT® test (Free CogAT® Practice Test, 2017) features verbal and spatial reasoning questions, while the Cognitive Abilities practice test (Free Cognitive Abilities Test, 2017) features mostly spatial reasoning questions.

The demographics form is a sheet of paper that will obtain basic information about the participants. Information obtained was gender (male, female, or other), age in years, year in school (Freshman, Sophomore, Junior, Senior, Beyond Senior), race (African American, Native American/Alaska Native, Native Hawaiian/Pacific Islander, Caucasian, Asian, or Other), ethnic background ('Hispanic or Latino' or 'Not Hispanic or Latino'), and the individual's Major. No other information was gathered, including the subjects' names.

Procedure

Participants first sat down to read and sign the informed consent before participation, and afterword was moved to the testing station. Subjects were seated and asked to complete two tests (Free CogAT® Practice Test, 2017, Free Cognitive Abilities Test, 2017) back-to-back with a pen on the desk. In the experimental group, the Hexbug brand "Fire Ant" robot will be in an obscured location before participants start the test. As they are signaled to begin, the robot will be suddenly moved out from its hidden location into the participant's sight, causing an unexpected event before the test proper starts. After the unexpected event the participants will continue with the test as normal.

After completing the test, subjects completed the demographics form, were debriefed, and were encouraged to leave for future participants. Participants were scored based on the number of questions answered correctly. These scores were entered into SPSS (IBM Corp., 2016) to measure variability, means, create tables and graphs, and to determine the significance of the results.

Results

Participants who did not receive a surprise had a lower score (M = 15.33, SD = 2.52) than individuals who did (M = 17.25, SD = 0.5). An independent sample t-test revealed that the mean difference was not significant, $t(5) = .186$, $p > .05$, $d = 0.166$. For graphs see Figure 1 in appendix.

Discussion

The hypothesis of this study was that there was some significance to the experimental treatment, positive or negative. This would mean that the surprise would cause either a noticeable increase or decrease in test scores. The results do not support this hypothesis, as while there was a difference between the two groups in test scores this difference was not statistically significant. This suggests that the treatment had no effect on participants. However, this study had multiple limitations.

The primary limitation for this study was the number of participants. The number of participants was significantly lower than what would be required to obtain significant results in the first place. The law of large numbers takes effect when there are at least 30 participants in each condition, while this experiment was unable to have 30 participants total, let alone in each group. This caused a decrease in the possibility of correctly identifying a significant effect.

The next limitation for this study revolves around the surprise used. There was no guarantee that the robot actually surprised participants due to flaws in the design. First, the sudden appearance of the robot alone may not have been surprising to the participant. Furthermore, participants would have known that this was an experiment, and have been expecting something to be different from the normal test-taking experience.

There is a possibility that the test used was not capable of catching the results that this experiment was after. Perhaps there was some effect, but it was in a separate area not covered by the content of the test. Another limitation to this study is that there was only one surprise at the beginning and no further surprises, so any effect that could have existed may have only affected the beginning of the test and nothing else.

The results of this experiment are contrary or neutral to past research, but the failings of this experiment should be taken into account. The research indicated that there would have been some form of effect, as per the hypothesis, and yet none was found in the experiment. Due to design, this experiment was unable to replicate any findings regarding flashbulb memory as there was only one test and no retest. The participants were all roughly the same age, so there would not likely be any differences due to age as observed by Schützwohl and Reisenzein (1999), where young adults had faster reaction to surprise while children and the elderly had slower reactions, or Vallet, Manzanero, Aróztegui, and García Zurdo (2017), where results indicated that there was a difference in qualities of memories between the young and elderly. Both of these studies had ages that varied from 18-47 for Vallet, Manzanero, Aróztegui, and García Zurdo (2017) or 8-69 for Schützwohl and Reisenzein (1999), while this experiment the participant age ranged from 18-25, much smaller than those two experiments. An experiment more in the

structure of that by Kock, Chatelain-Jardón, and Carmona (2009) would be interesting to consider for future research, with a test, surprise, and second test, rather than this experiment's single surprise followed by two tests that were essentially one test due to being back-to-back. Due to the lack of participants, this experiment was unable in any way to examine differences due to gender, as there was barely any difference in genders between individuals in this study (with one male and the six others all female) and the experiment was not configured for this anyway, as gender was not expected to be significant due to the experiment by Deng, Chang, Yang, Huo, and Zhou (2016), where it was found that there was no difference in emotionality between men and women. The research involving schemas and response time by Schützwohl (1998) found response times to schema-discrepant events increase with schema strength. This may have had some sort of effect, but this study was not designed with the capability to measure reaction time nor is such technology required readily available. Arnaudova, Krypotos, Effting, Kindt, and Beckers (2017) performed research regarding anxiety and the overgeneralization of stimuli, but is not particularly relevant for this experiment due to the lack of conditioning. This may be grounds for future research however, especially if there are multiple testing sessions for participants. As said earlier, Schützwohl and Borgstedt (2005) uncovered that during surprise, unpleasant stimuli were given more attention than otherwise. An unexpected electric shock is certainly not pleasant, but it is not clear just how negative such an experience is. As such, it is hard to determine if this surprise would be particularly spectacular for participants. This experiment also did not have a focus on attention, which would be difficult to measure without the right equipment. Meyer, Reisenzein, and Schützwohl (1997) found that a surprising change in

a focus stimulus increased reaction time, compared to similar change in distractor stimulus. This effect diminished on repetition. As before with Schützwohl (1998) this was not measured by this experiment but could be in future experiments. Although the pen suddenly shocking the participant would certainly count as a change in a stimulus, there was no distractor stimulus so that experiment would have to be a new design from the ground up. Gazendam and Kindt (2012) also performed research regarding anxiety, specifically the link between worrying and anxiety. Subjects were not told about the upcoming surprise such that they would not worry, avoiding any of the effects observed in Gazendam and Kindt (2012).

The results of this experiment have very little implications for general theories about surprise and cognitive performance. Due to the low number of participants it is unclear if there was an actual effect from the experiment, leaving the results scientifically insignificant compared to the past research. Overall more research is required to reach conclusions in this topic. An absence of significant results does not strictly mean that there is no effect, but that more is required in order to find it. As an example, research with a higher level of funding could use brain imaging devices in conjunction with tests and engineered surprises, along with a form of advertisement leading to a larger participant pool. This experiment serves as a foot-in-the-door for a relatively empty field.

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Appendix

Figure 1. Mean differences in scores based on control or surprise condition. Standard errors are presented in the graph by error bars attached on the columns.