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The Effects of Intrinsic and Extrinsic Motivation on Cognitive Performance in Humans

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Abstract

Previous research has shown that people are more likely to perform well on a difficult cognitive task compared to an easier cognitive task when they are intrinsically motivated. This finding can be explained by expectancy theory, the idea that behavior is influenced by the expectation of a reward, and that these rewards fall under two categories: intrinsic and extrinsic rewards. The current study examines the interaction of tasks of varying difficulty and extrinsic and intrinsic motivation, and whether these variables play a role in performance on a cognitive task. Friends and family of the researcher completed either an easy or difficult spatial abilities task (the Raven's Progressive Matrices) and for each correct answer were rewarded with either an extrinsic or intrinsic motivator (a piece of candy or a sticker). No difference was found between participants who were intrinsically or extrinsically motivated on the easy task, however, on the difficult task, intrinsically motivated participants performed slightly better than extrinsically motivated participants. The results did not reach significance. Limitations and future direction for the research are discussed.

Motivation is the concept of explaining why a person or an animal partakes in a certain behavior, usually due to a particular goal direction. Motivators can include avenues of need reduction like food and water, external incentives to behavior like prizes or money, and internal incentives like feelings of self-achievement (Gorman, 2004).

Most animal research uses food as a means of motivation as food is a salient stimulus in the life of an animal in regard to eating as a need reduction for hunger. One study that demonstrates food as a prominent motivator for animals used rats in a runway paradigm. Rats were exposed to a small food reward of two pellets in the runway and a large food reward of 24

pellets in the runway. Later, the rats were randomly assigned to the small or large food conditions and were placed in the runway with either two or 24 pellets, based on condition. Researchers discovered that rats ran faster for the large food reward in comparison to the small food reward. When the rats were switched into the other condition, the rats now receiving 24 pellets acquired the faster running behavior more quickly than rats now receiving two pellets (Capaldi & Lynch 1967). This research is important as it demonstrates the typical motivator of food in the lives of animals, particularly rats.

Although food and eating as a need reduction of hunger can be demonstrated in humans, food is not a priority motivator for the majority of people. People tend to be more motivated by things like money and feelings of achievement. These motivators can be sorted into two categories, extrinsic motivators and intrinsic motivators. Extrinsic motivators tend to be a tangible reward like money or a prize. Intrinsic motivators tend to be a feeling of satisfaction, like accomplishment or achievement (Gorman, 2004).

The interaction of extrinsic and intrinsic motivators can be further explained by Expectancy theory, originally put forward by V.H. Vroom in 1964, which suggests that we are motivated to perform a behavior based on the expectation that we will receive some sort of reward as the end result. The theory suggests that the probability that one will behave a certain way depends on two things: the desirability of the end result and the perception of the relationship between the behavior and the end result (Gorman 2004).

A modern day extension of the expectancy theory is work done by Kruglanski, Chernikova, & Schori-Eyal (2014) who proposed a similar model called motivational readiness. They suggested that motivation works through the interaction of wants and expectancies. A want is what one desires and an expectancy is the probability of fulfilling, and the costs and rewards of

the want. The researchers suggested that these two interworking concepts can explain the underlying processes of motivation. The motivational readiness model is similar to expectancy theory in that there is still the expectation of a reward after a certain action is performed, however, the reward can also be delivered in the form of fulfillment of the want.

With these theories in mind, research that tests the real life implications of expectancy theory can be referenced. One study examined the relationship between goal theory and expectancy theory by having 92 undergraduate students complete a number comparison task, where they had to identify the discrepancy between two sets of three numbers. The participants were given practice trials of the task. They were then randomly assigned to an easy condition or a difficult condition and given a goal score to try to attain. Before allowing participants to begin the task, they were asked how much effort they expected to use to attain the goal and if they expected to attain the goal at all. Results showed that participants performed better on the difficult task than they did on the easy task. The researchers attributed this to the finding that the participants in the difficult group reported the expectation that they'd need to expend more effort for their task and had lower expectations of their score, leading them to success. The participants in the easy group reported the expectation that they would not need to expend much effort in their task and expected a high score, leading them to poor performance (Matsui, Okada, and Mizuguchi, 1981). This research has important extensions on expectancy theory and outlines a real world example on how motivation can impact performance on cognitive tests.

A more recent study by Dodonova & Dodonov (2013) demonstrated this relationship between effort and task difficulty by identifying variables in cognitive processing on tasks of differing difficulty, including ability and accuracy. To do this, they timed 102 high school and undergraduate students on their completion of an anagram task where difficulty was manipulated

through word frequency. The students were then timed on their completion of a set of the Raven's Standard Progressive Matrices, which measured their cognitive abilities. Correlations were run to analyze the relationships between response time, ability, and accuracy. Results showed that participants scoring high in ability also had high scores in response time and accuracy compared to participants scoring low in ability. Surprisingly, as the tasks increased in difficulty, those with high ability increased in accuracy, however not in response time whereas the opposite was true for those with low ability scores. Although the researchers did not implicate motivational factors in these findings, the following research by Kahoe & McFarland (1975) can help explain why people perform better on difficult tasks due to motivational factors, like motivational personality types, which can be paralleled to ability types in this study.

Research by Kahoe & McFarland (1975) looked at the effects of motivation on cognition by giving out true and false personality inventories to 188 undergraduates at the beginning of the school year. This inventory assessed extrinsic and intrinsic motivational personality traits. One month before the end of the school year, the participants were asked to report their three most challenging courses and their three least challenging courses they had taken that year. At the end of the year, student marks for each course were correlated with their motivational type, either intrinsic or extrinsic, and their ratings of challenging and non-challenging courses. Results showed that intrinsic motivational personality traits were significantly correlated with marks in challenging courses but not significantly correlated with marks in non-challenging course. The opposite was true for extrinsic traits, such that extrinsic motivational personality traits were significantly correlated with marks in non-challenging courses but not significantly correlated with marks in challenging courses (Kahoe & McFarland, 1975). This research gives insight into

the two types of motivators that are salient to people, extrinsic and intrinsic motivators, and demonstrates how they can affect cognitive abilities and performance levels.

The current research looks to combine and extend these previous findings by experimentally inducing participants into extrinsic and intrinsic motivational mind sets. Using the concept of expectancy theory (Gorman, 2004) participants will be given extrinsic or intrinsic rewards after completion of a task. Easy and difficult versions of Raven's Standard Progressive Matrices (Raven, 2000), like that which was used in the research by Dodonova & Dodonov (2012) will be utilized as a spatial abilities cognitive task in the current study. Based on the findings by Matsui, Okada, and Mizuguchi (1981) and Kahoe & McFarland (1975) that people tend to perform better on difficult tasks due to expectancy factors of success and intrinsic motivators, it is hypothesized that participants receiving an intrinsic reward and completing the difficult task will perform highest on the cognitive task. It is hypothesized that participants receiving an intrinsic reward and completing the easy task will also perform fairly high, while the participants receiving an extrinsic reward and completing the easy task will do poorly and the participants receiving an extrinsic reward and completing the difficult task will perform the worst.

Method

Participants

The participants were 32 students recruited from friends and family of the researcher in London, Ontario, Canada. The ages of the participants ranged from 16 years to 27 years ($M=19.7$). An approximately equal number of males ($N=17$) and females ($N=15$) participated in the study.

Materials

Two partial sets of the Raven's Standard Progressive Matrices (Raven, 2000) were utilized as a dependent score measure. The Raven's Standard Progressive Matrices (RSPM) is a spatial abilities task that presents pieces of a pattern and then gives multiple choice answers for the next part of the pattern. The RSPM begins with a relatively simple question and progressively becomes more difficult with each subsequent question. The sets used in this study consisted of eight questions, with one set being relatively simple compared to the other set which was relatively challenging. The RSPM has been demonstrated to be very valid as it has strongly correlated with other tests of a similar nature ($r = .79$). The RSPM has also been demonstrated as highly reliable, showing an average split half reliability coefficient of .96 (Burke, 1972).

Pre-wrapped Tootsie Roll candies were used as an extrinsic motivator and stickers were used as an intrinsic motivator.

Procedure

Participants were explained the nature of the study and asked to provide written consent. Participants were then randomly assigned to one of four experimental groups: (1) extrinsic motivator for an easy task; (2) extrinsic motivator for a difficult task; (3) intrinsic motivator for an easy task; or (4) intrinsic motivator for a difficult task. Participants were asked to fill out demographic data of sex and age. They were then sat in front of a computer in a quiet area and were played a slideshow of either the easy task RSPM or the difficult task RSPM, based on condition. They were given two minutes to complete the whole task. They were asked to write down their answers on a provided answer sheet, and for each correct response, they were given either a candy or a sticker, based on condition. As soon as the participant wrote down a response,

they would either receive a reward or not and the researcher would use a mouse to click to the next question. At the end of the task, the researcher recorded each score out of eight and participants were debriefed. The participants in the extrinsic motivation conditions were encouraged to keep their candies.

Results

All data from the 32 participants were utilized in the study. Eight participants were in each of the four conditions (a summary of the raw data is available in Appendix A). A 2 X 2 between-subjects ANOVA was conducted with score on the RSPM cognitive task as the dependent variable and difficulty (easy/difficult) and motivation type (extrinsic/intrinsic) as the independent variables. The results indicated that there was a significant main effect for difficulty, $F(1, 28) = 33.9, p < .05$, partial $\eta^2 = .55$, with those in the easy condition ($M = 7.6, SD = .5$) performing significantly better than those in the difficult condition ($M = 5.1, SD = 1.6$). There was no significant main effect found for motivation type, $F(1, 28) = 0.76, p > .05$, partial $\eta^2 = .03$, however participants in the intrinsic condition ($M = 6.6, SD = 1.8$) performed slightly higher on the task than those in the extrinsic condition ($M = 6.2, SD = 1.8$). There was no significant interaction found for difficulty X motivation, $F(1, 28) = 0.76, p > .05$, partial $\eta^2 = .03$. In the easy condition, there was no difference in performance between those receiving intrinsic and extrinsic motivators. In the difficult condition, there was a slight difference in performance between those receiving intrinsic and extrinsic motivators such that those in the intrinsic condition performed slightly better than those in the extrinsic condition. These results were not significant. Figure one outlines the results.

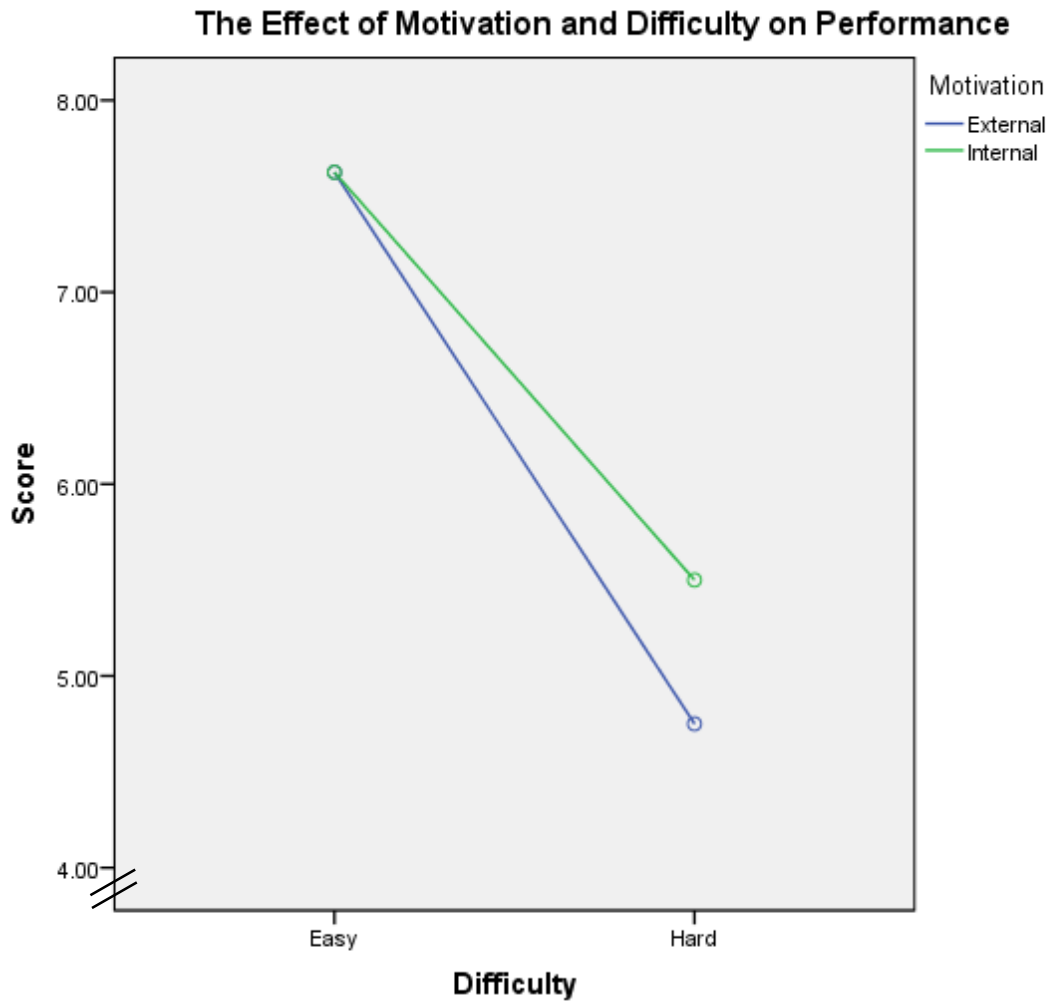


Figure 1: The interaction of level of difficulty (easy and difficult) and motivation (extrinsic and intrinsic) and its effect on scores on a spatial abilities cognitive task.

Discussion

The results of this study do not support the hypothesis. It was hypothesized that intrinsically motivated participants would perform best on the difficult task, followed by intrinsically motivated participants completing the easy task. It was expected that participants who were extrinsically motivated and completing the difficult task would perform the worst, with extrinsically motivated participants completing the easy task to perform just slightly higher. Although the pattern of results followed the expected direction, they did not reach significance. The results showed that regardless of motivation, participants performed significantly better on the easy task than the difficult task. On the easy task, there was no effect of motivation and both intrinsically and extrinsically motivated individuals performed the same. On the difficult task, intrinsically motivated individuals scored slightly higher than extrinsically motivated individuals, but this effect did not reach significance.

These results aimed to extend and combine past research by Kahoe & McFarland (1975) and Matsui, Okada, & Mizuguchi (1981) by combining the ideas of extrinsic and intrinsic motivational mind sets with cognitive tasks of varying difficulty, to see if these two variables had any interacting effects on overall performance. Since the results did not reach significance, methodological limitations should be taken into account and improved in further research.

One limitation is that the current study had a small sample size compared to past research. This study should be replicated with a larger sample in the hopes of achieving a significant result.

Another limitation that may explain the lack of significance obtained in this study is the choice of the cognitive test that was utilized. Although Raven's Standard Progressive Matrices were utilized by Dodonova & Dodonov (2013) in a similar study assessing ability, accuracy, and

response time on tasks of differing difficulties, it was also supplemented with an anagram test. It is possible that the spatial abilities that the RSPM measures is not affected by extrinsic and intrinsic motivations. Therefore, future studies should implement different cognitive tasks, like anagrams, number comparison tasks, or matching tasks to see if any are affected by motivation.

Another limitation that may explain the lack of significance in this study is the manipulation of motivation. As food is a salient motivator for rats (Capaldi & Lynch, 1967), self-achievement and knowledge of success is typically a salient motivator for people (Gorman, 2004). This study manipulated extrinsic motivation by using candy rewards and intrinsic motivation by using stickers as a symbol of success. Completing, and getting a good score, on the Raven's Progressive Matrices led to no other reward than either some candies or some stickers for the participants. In past research though, although correlational, rewards have been fairly salient to participants, for example: course grades (Kahoe & McFarland, 1975). Future research should seek to use more salient rewards, like partial course credits or social recognition. This use of different rewards may lead to finding significant results.

Another methodological change that can be made in future research to try to find significant results is the use of a within subjects design instead of a between subjects design. Since the Raven's Progressive Matrices was originally designed as an intelligence test (Raven, 2000), it is possible that the results were skewed by differing IQs in the sample. To avoid this, future studies could have participants complete multiple sets of RSPM, two easy sets and two difficult sets for different intrinsic and extrinsic rewards each time. That way, variable intelligence would be controlled for and a more individualistic attempt at studying motivation would be made.

The implications of this research mostly extend to educational and workplace settings. Motivation in these settings is widely researched and very important as it leads individuals to success, improvement, and efficiency in their school and work lives. Knowing what people find motivating aids employers and school administrators in designing their workplaces and programs so employees and employers, and students and teachers alike can reap the benefits. Although interesting work has been done on motivation in the past, this study was unable to find significant results to support it. Extrinsic and intrinsic motivation and task difficulty have important implications for the real world and should be continued to be studied to further extend our knowledge on how to motivate people.

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Appendix A

Case Summaries

		Difficulty	Motivation	Score	Gender	Age
1		Easy	Internal	7.00	Male	16.00
2		Hard	External	3.00	Female	21.00
3		Hard	External	5.00	Female	27.00
4		Easy	External	8.00	Male	19.00
5		Easy	Internal	7.00	Female	18.00
6		Easy	External	7.00	Female	18.00
7		Easy	Internal	8.00	Female	20.00
8		Hard	External	5.00	Female	21.00
9		Easy	External	8.00	Male	23.00
10		Hard	Internal	5.00	Male	17.00
11		Hard	Internal	4.00	Male	22.00
12		Hard	Internal	7.00	Male	17.00
13		Easy	Internal	8.00	Male	16.00
14		Easy	External	7.00	Female	18.00
15		Easy	External	7.00	Female	18.00
16		Hard	Internal	8.00	Female	24.00
17		Hard	Internal	2.00	Male	18.00
18		Hard	Internal	6.00	Male	20.00
19		Hard	Internal	7.00	Female	20.00
20		Hard	Internal	5.00	Male	24.00
21		Hard	External	4.00	Male	21.00
22		Hard	External	4.00	Female	17.00
23		Hard	External	7.00	Male	22.00
24		Hard	External	6.00	Male	25.00
25		Hard	External	4.00	Female	19.00
26		Easy	Internal	8.00	Female	20.00
27		Easy	Internal	8.00	Female	17.00
28		Easy	Internal	8.00	Male	18.00
29		Easy	Internal	7.00	Male	16.00
30		Easy	External	8.00	Female	19.00
31		Easy	External	8.00	Male	21.00
32		Easy	External	8.00	Male	18.00
Total	N	32	32	32	32	32
	Mean	1.5000	1.5000	6.3750	1.4688	19.6875
	Std. Deviation	.50800	.50800	1.73670	.50701	2.77590