Observation and Higher Level Cognition: A Study on Performance under Scrutiny

Jonathan E. Burton and Ezra C. Edmonds

Longwood University

Abstract

This study investigates the relationship between observation and tasks requiring the use of higher-level cognitive function. Our hypothesis was that observation would decrease the speed of performance on tasks requiring higher level cognitive function, as well as an increase in the number of mistakes made on the task. Each participant was either observed or not observed by a person walking behind them, while completing a task requiring higher-level cognitive function. Our results showed that observation decreased the speed with which participants completed the tasks, but failed to demonstrate that observation increased the number of mistakes made. These results could significantly improve the way that we understand observation.

*Keywords:* observation, performance, cognitive function, logic tasks

Observation and Higher Level Cognition: A Study on Performance under Scrutiny

Worker performance is highly important in western society; many companies go to great length to improve performance. Performance is important enough that specific employees, such as industrial organizational psychologists, specialize in improving it. With greater worker performance, society is more efficient, increasing the ability of the average person to allocate resources as they find appropriate. This, in general, improves the lives of those involved. With more productive workers, companies can have greater profits, which increases the ability of companies to provide better services at a lower cost to the general public (Vinchur & Koppes, 2007). Thus companies and other organizations have used numerous techniques to improve worker performance. Observation has been one of these techniques. The Hawthorne Studies helped to illuminate the effect of observation on performance (Muchinsky, 1987). These studies showed that when workers were observed, they became more productive. The researchers conducting the Hawthorne Studies demonstrated that observation has a large, measurable effect on worker performance, workers who perceived that they were being observed showed significantly greater performance than workers who did not feel that they were being observed (Levy, 2013).

Rothisburger and Dickson, along with their colleagues conducted the Hawthorne Studies, which demonstrated that observation can have a significant effect on performance. The Hawthorne Effect has been shown to be consistent across many studies (Olson, Verley, Santos, & Salas, 2004). These studies showed that factory workers that were being observed while they work were motivated by the presence of researchers, thus worked harder. Factory work, while of great value to society, does not require a high level of cognitive effort because it is largely repetitive labor. This raises the question of the generalizability of the Hawthorne effect concerning tasks that require higher cognition, because the Hawthorne studies focused on repetitive factory work. Performance of tasks that require higher level cognition have not been thoroughly studied to determine the actual effect of observation. Therefore the effect of observation in work environments that do require greater cognitive function, such as many modern information-based corporate settings, is unknown. To determine the effect of observation on cognitive function, one must consider its effects on the person. Previous studies have shown that observation is distracting from cognitive tasks and increases physiological arousal, levels of stress hormones, and feelings of self-awareness, none of which are conducive to the completion of tasks requiring higher cognitive function.

Physiological arousal is greatly increased by observation, and it is detrimental to performance on tasks that require higher-level cognitive function. Previous research has indicated that observation increases heart rate and blood pressure (Nagano, 2005). This is beneficial for tasks that do not require higher level cognition, since physiological arousal allows the person to perform tasks more quickly through the activation of the sympathetic nervous system (Garrett, 2009). However, physiological arousal can distract attention away from tasks that require concentration, such as logic tasks, making them more onerous for the person doing the task. One study, involving participants who were put in a high anxiety situation, demonstrated that when physiologically aroused, participants took more time to complete tasks requiring cognitive performance (Barnard, Broman-Fulkes, Michael, Webb, & Zawilinski, 2011). Physiological arousal was induced through a rapid breathing exercise, designed to induce rapid heart rate and high blood pressure. Participants were then required to perform a series of tasks, which required cognitive and psychomotor control. Participants that were high in anxiety showed more signs of physiological arousal, and took more time to complete the tasks. This demonstrates the idea that physiological arousal is both beneficial and detrimental depending on the cognitive requirements of the task (Barnard, Broman-Fulkes, Michael, Webb, & Zawilinski, 2011). Since observation increases physiological arousal (Nagano, 2005), tasks that require cognitive function should be influenced by observation.

As well as causing physiological arousal, observation increases psychological stress (Yantz, & McCaffrey, 2005). This psychological stress causes the release of cortisol, a major stress hormone. A study on decision making demonstrated that cortisol decreased participants’ performance in decision making tasks. This study involved the administration of cortisol to participants. These participants then took part in a gambling task, with both punishment and reward elements. Participants were both less sensitive to punishment and more motivated by potential rewards after being treated with cortisol. Both of these changes indicate a decrease in prefrontal activity which is important in regulating cognitive function. Stress hormones are detrimental while performing higher-level cognitive tasks due to the inhibitory effect of cortisol on prefrontal activity (Putman, Antypa, Crysovergi, & Does, 2010). When the prefrontal cortex is fully functional, higher-level cognition is easier and more efficient. Observation increases cortisol, which disallows full cognitive functioning. This impedes participants from performing as well as they would have without observation.

Observation also causes social psychological effects. Observation in this form is called social facilitation, which is defined as the effect that another person’s presence has on a person performing a task. Like physiological arousal this can have positive effects, specifically for tasks that are familiar to the performer; a trained musician plays better with an audience, for example (McCaffrey, Lynch, & Yantz, 2005). However, Yantz and McCaffrey demonstrated that third party observation significantly decreases the ability of participants to perform tasks that require focus (2005). Participants responded to the observation with decreased test scores, even when participants were informed that the observer was scrutinizing the examiner’s administration of the test, and not the participant’s performance (Yantz & McCaffrey, 2005). In another study, Researchers showed that the most significant factor to distraction was the participants’ perception that they were being observed. Similar reductions in ability to perform a memory recall task were achieved when participants were told that their progress was being video-recorded as compared to when they were being directly observed (McCaffrey, Lynch, & Yantz, 2005). Therefore, the key factor is not just the presence of the observer but the thought that one is being observed.

Along with social facilitation effects, observation causes public self-awareness (Putman, Antypa, Crysovergi, & Does, 2010). Public self-awareness is attending to how others perceive oneself. This means that one is concerned with others evaluations of oneself; one looks outward in order to understand themselves. Public self-awareness is not only observing oneself, but is also self-evaluation. Thus, when one exhibits public self-awareness one must think about how others perceive oneself, and then not only use this information to observe the self, but also use this information to evaluate the self (Baumeister, Bushman, Kassin, Fein, & Markus, 2011). Self-evaluation can lead to unpleasant self-discrepancies such as the idea that one is not as good at the task at hand as one previously thought. This may lead to greater cognitive resources being utilized in order to adapt to the cognitive discrepancies (Baumeister, Bushman, Kassin, Fein, & Markus, 2011). While undertaking a complex cognitive task, having public self-awareness splits focus between the two mental processes. This type of multitasking impairs performance on each task individually (Wang, & Tchernev, 2012). This decreases a person’s ability to focus, and perform on complex cognitive tasks.

Previous research has shown observation causes a person to be physiologically aroused, having higher blood pressure and heart rate; psychologically stressed, by leading to the release of cortisol; socially facilitated, in the negative form; and socially inhibited, by forcing the person to focus on how the observer perceives them. Therefore the combination of these physiological, neurological, and social psychological effects of observation all contribute to a reduction in the ability to perform complex cognitive tasks. Thus we predict that when presented with a logic task, participants who are closely observed will take more time to complete the logic task, and have a greater number of mistakes.

**Method**

**Participants**

The researchers used convenience sampling through an online signup system named SONA systems to obtain participants, there were a total of 112 participants (89 woman, 23 men, M age = 19.13, range 17-23). In our sample there were 50 freshmen, 27 sophomores, 19 juniors, and 16 seniors. The ethnicities of these participants were 14 Blacks, 3 Hispanics, 89 Whites, and 6 people who indicated that they were of another unspecified ethnic origin. Of the 112 participants, the researchers placed 59 participants in the control and 53 participants in the experimental group. 10 participants were excluded from the control group because of high noise levels while they were completing the study, while an additional seven participants were excluded for deviating from given instructions. Two participants were excluded from the experimental group, also for deviating from given instructions. In total, 19 participants were excluded from the study. Participants were college students from a medium size liberal arts university in the eastern United States. Participants received extra credit points in psychology classes that they were taking for participating in this study.

**Materials and Procedure**

The researchers gave theparticipants three logic puzzles (Appendix A), these logic puzzles consisted of a series of hints which the participants had to use to correctly order a set of items. These puzzles were retrieved from the website enchantedlearning.com. Along with each set of logic puzzles each participant was given a questionnaire with demographic information and two questions presented on Likert scales. A stopwatch application on an iPhone was used to record the finish time of each participant.

Participants signed up for the research study under the deceptive title of “The Effect of Time of Day on Performance of Logic Tasks” on the online signup system. Upon arrival at the research study, researchers required the participants to sit in chairs behind desks, facing the same direction. After all participants had arrived and had been seated, researchers briefed the participants and informed them that they are free to leave at any time without incurring penalty. A researcher then asked the participants if they want to see the consent form, and a paper copy was provided to participants who desire it. Participants then completed the three logic puzzles (Appendix A). Researchers instructed participants to raise their hand upon the completion of their set of logic puzzles; an experimenter then recorded the time taken in seconds.

In the experimental condition, a researcher observed the participants by walking behind them in a time frame of two minutes. To do this, the experimenter waited thirty seconds after participants have commenced their work on the logic puzzles. The experimenter then walked to the first participant in the row and waited for ten seconds behind him or her at a distance of one foot while looking at the participant’s work on the logic puzzles. After this, the experimenter moved on to the second participant and repeated the procedure. The experimenter continued this process until all participants had been observed. Having completed observation of all participants, the experimenter waited for the amount of time remaining in the two minute time frame before beginning the procedure again. Therefore: when testing a single participant, the experimenter waited for one minute and 50 seconds; when testing six participants, the experimenter waited for one minute. In the control group there was no experimenter walking behind the participants; instead both experimenters stood at the front of the room. After all participants completed the logic questions, participants were asked to fill out a demographic questionnaire along with two questions on a Likert Scale (Appendix B). The Likert scale questions were measured from one to seven and asked how frustrated and uncomfortable the participant felt while participating in the study. Once all participants completed the questionnaire and Likert Scale questions, the researchers debriefed the participants. In the debriefing researchers revealed the true title and goals of the study.

**Results**

To determine the effect of observation on completion of logic tasks, we measured the time in seconds participants took to complete the three tasks and the number of mistakes the participants made. An independent *t* test showed that participants who were directly observed by an experimenter took more time, measured in seconds, to complete the logic puzzles (*M* = 275.80, *SD* = 73.60) than participants who were not observed by an experimenter walking behind them (*M* = 249.5, *SD* = 60.27). The two groups’ mean times to complete the logic puzzles were significantly different from one another, *t*(91) = 1.86,*p =* .033, *d* = .398, 95% CI[-1.27, 53.88] (one-tailed). Figure 1 shows the mean time to complete all three logic puzzles for both the control and experimental groups. Using a second independent *t* test we found no significant difference in number of mistakes made on the logic puzzles between participants who were observed directly by an experimenter (*M* = .80, *SD* = .75) and participants who were not observed (*M* = .60, *SD* = .73), *t*(91) = 1.35, *p* = .091, *d* = .270, 95% CI[-.10, .52] (one-tailed). Figure two shows the mean number of mistakes made by both the control and experimental groups.

**Discussion**

Results supported the hypothesis that participants would take more time to complete logic tasks while being observed than when not being observed. We believe that this was because of the physiological arousal, increased heart rate and blood pressure (Barnard, Broman-Fulkes, Michael, Webb, & Zawilinski, 2011); psychological stress and anxiety, which stimulates release of cortisol (Yantz, & McCaffrey, 2005); and social psychological effects (McCaffrey, Lynch, & Yantz, 2005). All of these factors have been previously shown to be caused by observation. These factors each contribute to the arousal and stress that a participant experiences, which may cause participants to have poorer cognitive function.

However, our hypothesis that observation would increase the number of mistakes that participants made was not supported by the data. This may be caused by a small possible range in the number of mistakes participants could make, because participants were only asked to complete three logic puzzles. If the test had more logic puzzles, there would have been more opportunity for participants to make mistakes, this would have enabled the effect of the observation to be viewed more fully. A small sample size could have also contributed to the lack of significant difference between the two groups. A larger sample of participants would make the difference between the groups more pronounced. It is also possible that when observed, participants chose to simply work slower in order to make fewer mistakes. This could account for why we found a significant difference for amount of time taken but not number of mistakes made.

While there was a significant difference in the amount of time taken between groups, there were a number of limitations that may have reduced the magnitude of the difference between the groups and thus the overall generalizability of this study. One possible confounding variable was noise emanating from an adjoining room. This noise caused the data from groups of participants that were exposed to vary systematically from the rest of the dataset. 10 participants had to be excluded for this reason, as specified in the participants section of this paper. Another possible limitation was the variation of rooms, since the layout of each room we performed the experiment in was not uniform. Some of the rooms had participants closer to the front, where both experimenters where standing in the control condition. This may have caused participants who participated while in those rooms to have a greater perception of being observed, even in the control group. Future studies could account for this by assuring that research takes place in uniform rooms.

Another limitation was the variation in the number of participants per time slot. We noted that in timeslots that had fewer participants, participants completed the logic puzzles more quickly. This may have caused greater variation in the data, which would in turn cause the groups to have larger standard deviations, thus reducing the significance of the results. Another confounding variable was the presence of experimenters in the room while participants were working on the logic tasks in the control group. Participants in the control group may still have felt observed, even though experimenters were not actively walking behind them and looking at their work. Because of constraints placed on our experimental design, it was not possible to conduct the experiment without an experimenter in the room. This weakened our manipulation, since the difference between the control and experimental group was not as great as it would have been if the experimenters were not in the room during the control condition. A future direction for this study would be to remove the experimenters during the control condition in order to see the effect of observation more clearly.

In addition to accounting for confounding variables, there are a number of additional alterations that future researchers could apply to strengthen the validity, and thus generalizability, of this study. One way validity could be increased is to strengthen the manipulation of the independent variable. This could be done by the experimenter who is observing the participants drawing the participants’ attention to himself. Participants who were not fully aware of the observer would experience less anxiety from the observation. Therefore if the experimenter drew more attention to himself during the experimental condition, participants would give less attention to the logic task. Having the observer in plain view through the use of a medium such as a mirror, or some form of notification of observation are also ways of achieving this effect.

Another way to strengthen the manipulation of the independent variable is to increase the difficulty of the logic puzzles. Future researchers could simply use more difficult logic puzzles in order to achieve this effect; however, they could also instruct participants to refrain from writing notes while attempting to solve the puzzle. Participants would be forced to complete the logic puzzles using only what they could process in their working memory, this requires greater concentration. Therefore, because participants would require greater focus, distraction caused by observation would have a larger effect; thus causing the difference between the control and experimental groups to be greater. This, along with the other alterations, would increase the validity of the results.

Additionally future researchers might consider utilizing a paired–subjects design when studying this topic as a means to aid validity. Participants for this study exhibited a range of skill sets, with some demonstrating less ability with logic tasks and others excelling far beyond the speed and skill with which a typical participant completed the logic task. A paired-subjects design would enable researchers to control for these participants’ widely varying abilities, thus enabling researchers to collect data with more validity.

Another direction for future study would be to examine how familiarity with logic tasks might impact a participants’ ability to perform under scrutiny. Participants who are more skilled will perform the task faster, and one must question whether participants with a great deal of practice might experience the Hawthorne effect, despite the task requiring higher-level cognitive function, due to previous learning. This means that even though the task would require higher level cognition, the person’s familiarity with the task would enable the Hawthorne Effect to take place, because the logic task might have become more akin to a repetitive task similar to the ones in the Hawthorne studies (Muchinsky, 1987).

A real-world application of the information that this data provided would be business. Many businesses have tours passing through their workplace, which, due to the Hawthorne Effect improves worker performance for jobs that require lower-level cognitive function (Muchinsky, 1987). However, businesses might want to prevent tour groups from going into areas in which workers are performing tasks requiring higher level cognitive function, because according to the results received from this experiment it might decrease the productivity of these workers by increasing the time that tasks take for completion. Another real-world application would be in testing. The results obtained from this experiment indicate that distraction could be a factor that should be taken into consideration when exams are being conducted. Standardized exams, such as the GRE and the SAT, have proctors who walk behind the test-takers and monitor behavior in order to prevent cheating. This may distract test-takers, causing them to run out of time, and thus receive lower scores.

Our research indicated that observation causes people to take a greater amount of time on tasks requiring higher-level cognitive function. This information could be useful in various circumstances, including in a business context, an academic context and everyday life.

Just as the Hawthorne studies revolutionized the study of worker efficiency in business, this line of research could revolutionize ideology concerning corporate management. This study indicates that perhaps when others are attempting to complete a complex task swiftly, the best course of action is often to leave them alone.

References

Barnard, K. E., Broman-Fulkes, J. J., Michael, K. D., Webb, R. M., &Zawilinski, L. L. (2011). The effects of physiological arousal on cognitive and psychomotor performance among individuals with high and low anxiety sensitivity. *Anxiety, Stress, & Coping, 24*(2), 201-216. doi:10.1080/10615806.2010.494328

Baumeister, R. F., Bushman, B. J., Kassin, S., Fein, S., & Markus, R. (2011). *Social psychology: New perspectives on “commonsense”.* Mason, OH: Cengage Learning

Garrett, B. (2009). *Brain & Behavior: An introduction to biopsychology*. Los Angeles, CA: SAGE Publications

Levy, P. E. (2013). *Industrial organizational psychology: Understanding the workplace.* New York, NY: Worth Publishers

McCaffrey, R. J., Lynch, J. K., &Yantz, C. L. (2005). Third party observers: Why all the fuss? *Journal of Forensic Neuropsychology, 4(2),* 1-15. doi:10.1300/J151v04n02\_01

Muchinsky, P. M. (1987). *Psychology applied to work: an introduction to industrial and organizational psychology* / Paul M. Muchinsky. Chicago, Ill. : Dorsey Press, 1987.

Nagano, Y. (2005). The effect of evaluation observation during mental tasks on cardiovascular responses. *Japanese Journal of Psychology, 76(3),* 252-259. doi:10.4992/jjpsy.76.252

Olson, R., Verley, J., Santos, L., & Salas, C., (2004). What we teach students about the hawthorne studies: A review of content within a sample of introductory I-O and OB textbooks. *The Industrial-Organizational Psychologist, 41(3),* 23-39. Retrieved from https://www.siop.org/tip/backissues/Jan%2004/pdf/413\_023to039.pdf

Putman, P., Antypa, N., Crysovergi, P., & Does, W. A. J. (2010). Exogenous cortisol acutely influences motivated decision making in healthy young men. *Psychopharmacology 208,* 257-263. doi:10.1007/s002113 009 1725 y

Vinchur, A., & Koppes, L. (2007). Early contributors to the science and practice of industrial psychology. In *Historical Perspectives in Industrial and Organizational Psychology* (1st ed., p. 73-60). Mahwah, New Jersey: Lawrence Erlbaum Associates,.

Wang, Z. &Tchernev, J. M. (2012). The “myth” of media multitasking: Reciprocal dynamics of media multitasking, personal needs, and gratifications. *Journal of Communication 62,* 493-513. Retrieved from:https://www.siop.org/tip/backissues/Jan%2004/pdf/413\_023to039.pdf

Yantz, C. L., & McCaffrey, R. J. (2005). Effects of a supervisor’s observation on memory test performance of the examinee: Third party observer effect confirmed. *Journal of Forensic Neuropsychology, 4(2),* 27-38. doi: 10.1300/J151v04n02\_03

*Figure 1.*The mean time in seconds taken by participants to complete the take in both the observation and control conditions.

*Figure 2.*The average number of wrong answers given by participants in both the Observation and Control conditions.

Four children weigh different amounts. Figure out who weighs what.   
1. Abe weighs more than Dan

2. Sue weighs less than Mary.

3. Sue weighs 20 pounds more than Dan.

4. Mary weighs more than Abe.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Weights: | 80 Pounds | | 90 Pounds | | 100 Pounds | | 110 Pounds | |
|  |  |  | |  | |  | |  | |
| Abe | \_\_\_\_\_\_\_\_\_ |  | | . | | . | | . | |
| Dan | \_\_\_\_\_\_\_\_\_ |  | | . | | . | | . | |
| Mary | \_\_\_\_\_\_\_\_\_ |  | | . | | . | | . | |
| Sue | \_\_\_\_\_\_\_\_\_ |  | | . | | . | | . | |

Four children have different favorite animals. Figure out who likes which one.   
1. Sue's favorite animal is smaller than Ben's.

2. DiDi's favorite animal is bigger than Sue's.

3. Bill's favorite animal is bigger than Ben's.

4. DiDi's favorite animal is smaller than Ben's.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Animals: | | Butterfly | | Cat | | Horse | | Elephant | |
|  | |  | |  | |  | |  | |
| Sue | | \_\_\_\_\_\_\_\_\_ | | . | | . | | . | |
| Bill | | \_\_\_\_\_\_\_\_\_ | | . | | . | | . | |
| DiDi | | \_\_\_\_\_\_\_\_\_ | | . | | . | | . | |
| Ben | | \_\_\_\_\_\_\_\_\_ | | . | | . | | . | |

Retrieved from http://www.enchantedlearning.com

Four children have four different doctor appointments. Read the clues to find out who had the first, second, third, and fourth appointment.

1. Joe's appointment is after those of Kim and Bob.  
2. Bob's appointment is before Kim's.  
3. Amy's appointment is after Joe's.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Times: | 1:00 | 2:00 | 3:00 | 4:00 |
|  |  |  |  |  |
| Joe | \_\_\_\_\_\_\_\_ | . | . | . |
| Kim | \_\_\_\_\_\_\_\_ | . | . | . |
| Amy | \_\_\_\_\_\_\_\_ | . | . | . |
| Bob | \_\_\_\_\_\_\_\_ | . | . | . |

Retrieved from http://www.enchantedlearning.com

Please fill in blanks and circle the correct information.

Sex: Male Female Other: \_\_\_\_\_\_\_\_\_ Age: \_\_\_\_ Academic Year: Freshman Sophomore Junior Senior Other: \_\_\_\_\_\_\_

Ethnicity: Asian Black Hispanic White Other: \_\_\_\_\_\_\_\_\_

Have you completed any of these logic puzzles before? Yes No

Did an experimenter walk behind you while you were completing this study? Yes No

Please Circle the number that best describes your experience

I felt uncomfortable while doing this study.

1 2 3 4 5

Strongly Disagree Strongly Agree

I felt frustrated while doing this study.

1 2 3 4 5

Strongly Disagree Strongly Agree