The Effects of Physical Exertion on Eyewitness Memory among RCMP Cadets

A Thesis

Submitted in Partial Fulfillment of the Requirements

for the Degree of

Bachelor of Arts (Honours) in Psychology

Supervised by Dr. Chris Oriet and Tansi Summerfield, M.A.

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April, 2020
Acknowledgements

I would like to extend my sincere gratitude to my supervisor, Dr. Chris Oriet, for his support, guidance, and patience throughout this past year. I would like to extend this same gratitude to my co-supervisor, Tansi Summerfield, M.A., for her unique contributions, dedication, encouragement, and positivity. This project would not have been possible without their unending encouragement and assistance in my endeavors, and I so grateful for their investment in my success. I would also like to extend my thanks to Greg Krätzig, Director of Research and Strategic Partnerships at Depot Division, for his involvement in this work, as well as Chet Hembroff, M.A., Research Analyst at Depot Division, for his time and assistance in completing this project with the RCMP. Finally, I would like to thank Ryan Fitzgerald, PhD, for supplying the videos and lineups that were used for this project.
Dedication

I would like to dedicate this project first to my family. Their support, and patience with me throughout this project has provided me with the love and encouragement to succeed. I would also like to extend my sincerest gratitude to my Honours cohort, and more importantly, my friends. In particular, I would like to thank Eddye Kirk, Tenielle Workman, Emilio Filomeno, Louise Castillo, Michaela Flaman, and Bethany Sander. These individuals believed in my ability to succeed, provided me with emotional support, pushed me to work harder, and modelled the kinds of individuals I hope to have the pleasure of working with in the future.
Abstract

Previous research concerning the accuracy of eyewitness lineup identifications suggests various factors impact cognitive performance. Most relevant to the present study was the effect of physical exertion on facial recognition memory, as well as the factors that contribute to incorrect misidentifications of an innocent person from a lineup. The present study considered both of these factors, and executed a replication and extension of Hope et al.’s (2012) work, which examined the effect of physical exertion on recall and recognition memory among Canadian police officers. Unlike Hope et al.’s research, the present study included a target-absent condition to specifically consider the effects of physical exertion on misremembering. In order to do so, RCMP cadets from Regina Depot Division were assigned to either a Physical Exertion or Control group. Participants in the Physical Exertion group completed a physically demanding task to exert them to a similar degree as they would be exerted in the field. All participants viewed a video that depicted a theft, and then completed a recognition memory task. Non-exerted participants were found to be more accurate in identifying the culprit in a target present lineup than exerted participants, therefore highlighting the negative impact of exertion on cognitive performance. However, exerted participants showed greater accuracy in correctly rejecting target absent lineups than non-exerted participants. Possible implications of metamemory on response accuracy were explored.

Keywords: eyewitness lineup identification, physical exertion, misremembering, recognition memory.
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The Effects of Physical Exertion on Eyewitness Memory Among RCMP Cadets

When asked to identify a culprit from an eyewitness lineup, witnesses can misidentify an innocent person. Despite incorrectly misidentifying an innocent suspect, eyewitnesses tend to be just as confident and sincere in their misidentifications as those who correctly identify the culprit from a lineup (Wells, 1993). These incorrect misidentifications of innocent suspects are the primary cause of documented false convictions (Wells, 1993), and make it difficult for legal proceedings to confidently rely on the suspect identifications made in an eyewitness lineup. In laboratory experiments testing eyewitness identifications, researchers attempt to simulate a reality where the person in the lineup is guilty and a reality where the person in the lineup is innocent. These are referred to as target-present and target-absent lineups, respectively.

The variance among identifications of a suspect in target-present and target-absent lineups is attributable to several factors (Andersen et al., 2014), some of which originate from errors in how the witness remembers the event, and some of which arise from how memory is tested. These latter, external factors are of particular interest to researchers because - unlike the witness’ memory - they can be controlled. Thus, research on eyewitness memory tends to focus on the overall impact that external variables have on the cognitive processes that are involved in eyewitness lineup identifications.

Previous research has highlighted the importance of lineup presentation style for discouraging incorrect misidentifications (Andersen et al., 2014; Cutler & Penrod, 1988; Garrioch & Brimacombe, 2001; Greathouse & Kovera, 2009; & Steblay et al., 2001). An eyewitness lineup can be administered sequentially or simultaneously. In a simultaneous lineup, the witness is informed that the suspect may or may not be present, and is then shown all photos simultaneously (Steblay et al., 2001). In presenting the lineup this way, the likelihood increases
that the witness will respond based on relative judgement. In this case, the witness will have identified the individual who most closely resembles the suspect relative to the other members of the lineup, rather than considering each lineup member individually. Eyewitness identifications that are based on relative judgements result in more frequent instances of incorrect misidentifications of an innocent person. To account for these limitations, Lindsay and Wells (1985) suggested the sequential lineup presentation style. A sequential lineup presents the witness with a photo of each member of the lineup one at a time. Each time witnesses are shown a photo, they are required to decide whether the individual is innocent or guilty before being able to move on to the next photo. This reduces the tendency for the witness to rely on relative judgements, thus reducing the likelihood for incorrect misidentifications of an innocent person (Steblay et al., 2001).

Another factor that impacts an individual’s ability to accurately respond to a lineup is their pre-determined cognitive abilities (Andersen et al., 2014; Morgan et al., 2007). Morgan et al.’s (2007) research suggested the importance of pre-determined trait ability for facial recognition as a predictor of performance on eyewitness lineup identifications. Following exposure to a high-stress event designed to mimic a survival scenario, Morgan et al. (2007) administered the Wechsler Face Test to military soldiers. Results indicated that the soldiers’ ability to accurately recognize faces during the Wechsler Face Test predicted their subsequent accuracy in choosing from a sequential lineup that was administered soon after. They also found that the soldiers with less cognitive ability for facial recognition were also less likely to correctly identify the culprit in the lineup task, and were more likely to incorrectly identify an innocent person. Andersen et al. (2014) found further support for the importance of an individual’s pre-determined cognitive ability to recognize faces. Like Morgan and colleagues (2007), their
research also found that this ability generally predicted eyewitness lineup identification accuracy as a function of lineup presentation style. Their research suggested that individuals with better facial recognition ability who were shown a simultaneous lineup reported fewer false identifications and more correct identifications. Based on these findings, Andersen et al. (2014) and Morgan et al. (2007) suggest that an individual’s pre-existing cognitive abilities are a strong determinant of their performance on an eyewitness lineup identification task.

Morgan et al. (2004) further investigated the effects of stress on eyewitness identification performance by manipulating the nature of the participants’ interaction with the target culprit. They chose to assess the accuracy of suspect recognition following either a high-stress or low-stress interrogation to mimic the same alterations in hormone levels (cortisol, epinephrine, and norepinephrine) that occur in real world, threat-to-life events. In a sequential eyewitness identification lineup task, participants in the high-stress condition were less likely to correctly identify the suspect from the lineup. These findings suggest that highly stressful situations that mimic real-world traumatic scenarios and increased stress hormone levels tend to increase the rates of incorrect misidentification and decrease the rates of correct identification.

Currently, research within the field is growing to further investigate the effects of physical exertion on eyewitness identification task accuracy. Specifically, more research is needed to explore the effects of high-intensity, exercise-induced physical exertion in order to further explore the nature of its effects and understand practical implications for its involvement in the justice system. While some researchers have suggested that certain degrees of physical exertion enhance an individual’s performance on a cognitive task, other studies have suggested that physical exertion has a negative impact on cognitive performance (Giles et al., 2019). This relationship has been described as the Inverted-U effect and has been used frequently to illustrate
the effects of physical exertion on cognition (Brisswalter et al., 2002). This effect depicts the points of optimal arousal for enhancing cognitive performance, and those that impair it. In line with this model, the extremes of physical exertion impair cognitive ability, while a moderate level enhances it (Brisswalter et al., 2002). To try and gain a better understanding of this relationship, Brisswalter et al. (2002) chose to examine a review of the literature within the realm of sports. When an individual is participating in a physically-engaging sport, they are generally required to simultaneously engage in high-levels of physical exertion while also being expected to perform optimally on cognitive decisional and perceptual tasks. Brisswalter et al. (2002) wanted to gain a better understanding of the impact of acute, yet constant, physical exercise on the cognitive processes that are required when playing sports, such as reaction time. From their review of the literature on the effects of this associated arousal on cognitive tasks, Brisswalter et al. (2002) suggested that, as arousal increases during moderate levels of exercise intensity, attention narrows and optimal cognition is reached where only relevant and salient cues are processed. As exercise becomes more intense, therefore increasing arousal levels, attention narrows even further to a point where even relevant and salient cues are missed. Similarly, Libkuman et al. (1999) investigated the effects of physical exertion on memory for three different types of information (central detail, background detail, and gist which was a combination of central and peripheral). The researchers were interested in determining whether physical exertion would impair an individual’s ability to encode all types of information from an event. Libkuman and colleagues (1999) found that, when participants were exerted with physical activity at a high intensity, they were able to recall fewer central and peripheral details of the event. Therefore, these findings support the notion that exerting participants to this degree impairs memory not only for background details, but for relevant and salient cues as well.
Along with the degree of intensity of the physical activity, Giles et al. (2019) suggest that the domain of the cognitive task plays a part in how physical exertion impacts an individual’s performance. Certain domains of cognition, such as those considered to be higher-level processing (e.g., memory for faces), are more susceptible to impairment than lower-level cognitive processes (e.g., response inhibition). With this in mind, Giles et al. (2019) suggested an interaction between the nature of the cognitive process and the degree of exercise intensity. Previous research had suggested that acute, moderate-intensity exercise has the ability to enhance cognitive performance, while extended, high-intensity physical activity tends to impair executive functions. To explore the nature of this relationship between high-intensity physical activity and cognitive performance, Giles et al. (2019) chose to manipulate the interaction between the two. Using active duty soldiers from the United States, the researchers manipulated load carriage (degrees of body armor: low - standard uniform: 8.8 kg, medium - plate carrier: 47.2 kg, high - body armor vest: 50.7 kg) while having participants perform go/no-go tasks during two separate foot marches which were designed to achieve a level of physical exertion (measured with the Rated Perceived Exertion scale; Borg, 1998) in order to elicit similar cognitive changes that would occur in a real-world military situation. The go/no-go task was a response inhibition task used to assess cognitive performance that required participants to respond to selected gunfire sounds while remaining unresponsive to others. The findings from this study illustrated the negative effects of sustained physical exertion and load carriage on response inhibition performance. Across all load conditions, participants reported higher proportions of false alarms, and lower proportions of correct responses. With specific regard to the effects of physical exertion, the researchers found that participants demonstrated increased hits and response inhibition (sensitivity) during the first five minutes of their march, when
physical exertion levels were lowest. During the last five minutes of the march, when participants were most exerted, the proportion of false alarms was highest. Their findings confirm previous research and are in line with the theories that high-intensity exercise impairs executive cognitive processing.

Hope et al. (2012) were similarly interested in whether high-intensity physical exertion would impair executive cognitive processes. Therefore, they chose to investigate whether physical exertion would impact an individual’s ability to recall and recognize faces in an eyewitness lineup task that they had viewed directly after being physically exerted. Specifically, Hope et al. (2012) chose to measure the effects of this relationship in a population of Canadian police officers. In order to physically exert the participants to the same degree they would be while on duty, the researchers had them engage in a high-intensity assault of an exercise bag and ensured that they were sufficiently exerted using Polar Heart Rate monitoring belts. Following the physical activity, participants were taken to another room designed to look like an inhabited trailer for the scenario phase of their study. On the way to the second location, each participant passed the same individual in the hallway (incidental target). Participants then entered the live scenario in which an agitated and aggressive individual (target culprit) shouted at them to leave his property. This individual’s face was later included in the eyewitness lineup identification task as the suspect. The participants’ cognitive performance was then assessed with both a recall and recognition task. First, the recall task tested the participants’ ability to encode information that had been given to them prior to the physical activity by questioning them about the details of the briefing they had been given. Second, the recall task asked each participant to recall everything they could about the incidental target that they had seen directly following the physical activity. As Hope et al. (2012) expected, participants who were physically exerted reported fewer correct
details of the briefing following cued recall than participants in the control condition. They also reported fewer correct details about the incidental target than those in the control condition. Hope et al. (2012) then assessed the performance of each participant on the eyewitness lineup identification task as a measure of recognition memory for the culprit target. Compared to the control condition, participants who were physically exerted demonstrated lower identification accuracy, and were less likely than participants in the control condition to correctly identify the critical target. Physically exerted participants also made more filler identifications than those in the control condition, and were more likely to reject the target-present lineup.

While Hope et al. (2012) found a significant effect of physical exertion on a police officer’s ability to accurately respond to a target-present lineup, the researchers did not present participants with a target-absent lineup. Therefore, the present study introduced a target-absent lineup to determine whether physical exertion had similar effects on misremembering. By including a target-absent lineup, the present study introduced a scenario in which participants may make filler identifications. This allowed the present study to introduce a scenario that is common in real-life situations, as the identity of the culprit is unknown to police officers at the time of constructing a lineup. Furthermore, it is possible that responses could vary among participants as a function of a factor other than recognition memory accuracy. For example, assuming that recognition memory is unaffected by exertion, it is possible that exertion affects another variable, such as confidence in memory accuracy, which in turn influences lineup decisions. If this is the case, the effects of exertion could manifest differently in target present and target absent conditions. Specifically, lower confidence in memory could reduce participants’ willingness to make a positive identification. This would reduce the number of correct responses in the target present condition, but also reduce the number of incorrect
responses in the target absent condition. For this reason, the introduction of a target-absent lineup could help to adjudicate between these two possibilities.

Previous research has suggested that participants report higher proportions of false alarms for response inhibition when physically exerted (Giles et al., 2019). Therefore, including a target-absent lineup allowed the present study to test whether similar effects can be found with facial recognition by measuring proportions of innocent suspect misidentifications. To do so, the single-lineup paradigm was used (Oriet & Fitzgerald, 2018). In experiments using a traditional dual-lineup paradigm, researchers manipulate the presence of the perpetrator among a group of fillers, creating issues such as a lack of ecological validity and a consistently greater similarity between the perpetrator and fillers than between the innocent suspect and fillers. However, with the use of the single-lineup paradigm, the present study increased its experimental control over the makeup of the lineup across all conditions without compromising the ecological validity of the results. Because it uses the same lineup for each condition, the innocence of those in the lineup is therefore determined by the video the participants had previously watched, with the fillers matched to the individual suspected of the crime. Using the single-lineup paradigm not only introduced a target-absent lineup that was not included in Hope et al.’s (2012) study, but helped to avoid filler-similarity issues that can arise when comparing a target-present and target-absent lineup containing different suspects, as in the traditional dual-lineup paradigm.

**Hypotheses**

The hypotheses for the present study were based on previous research regarding the effects of physical exertion on cognitive performance as well as the results found in Hope et al.’s (2012) study. I hypothesized that the present study would yield similar results regarding the effects of physical exertion on accuracy for target-present eyewitness lineup identifications.
Because the target present condition of this study serves as a replication of Hope et al.’s (2012) study, I predicted that those in the Physical Exertion group would be less accurate than those in the Control group in correctly identifying the culprit from the lineup. If these findings are not replicated, it could suggest that there is another variable resulting in variability between Hope et al.’s (2012) findings and my own. For example, the variability between participants’ experience as police officers (i.e., cadets progressing through the CTP at the Royal Canadian Mounted Police (RCMP) in my study versus graduated police officers with years of field experience in Hope et al.’s study).

The present study also introduced a target-absent condition. If physical exertion reduces recognition memory accuracy overall, it is expected that exerted participants will be more likely to falsely identify the suspect as the target in the target-absent condition than participants in the control group. However, another possibility is that exertion influences participants’ confidence in their recollection of the target event. Recall that in Hope et al.’s study (2012), exerted participants were less likely to identify the target in a target-present lineup. This result is expected if exertion impairs recognition of the target. However, the same result would be observed if exerted participants were less confident in their memory for the target, even if their actual memory was the same as that of non-exerted participants. This is because participants who are less confident in their recollection might be less willing to make a positive suspect identification. These possibilities can be distinguished with the inclusion of a target-absent condition. If exerted participants are less confident in their memories and less willing to make a positive suspect identification, they will make fewer false alarms (i.e., they will be more likely to reject the lineup) than non-exerted participants, and will make fewer filler identifications. The present study was designed to adjudicate between these competing hypotheses.
Method

Participants

Participants were cadets recruited from the RCMP and were enrolled in the Cadet Training Program (CTP) at the Depot Division in Regina, Saskatchewan at the time of data collection. Cadets were provided with an Invitation to Participate (Appendix B) and were given a consent form to read and sign prior to participating (Appendix C). The sample included four troops, each with approximately 32 cadets (\( N = 118 \)). The four troops were arbitrarily assigned to one of four conditions: Exertion/Target Present group; Exertion/Target Absent group; Control/Target Present group; Control/Target Absent group. The average age of the participants was 29 and ranged from a minimum of 20-years-old to a maximum of 44-years-old.

Measures

Rated Perceived Exertion Scale

Borg’s (1998) Rated Perceived Exertion (RPE) Scale was used to quantify feelings of overall physical exertion (Appendix D). This self-report measure uses a number rating from 6 to 20, paired with verbal explanations, to determine the level of physical exertion the participants are experiencing.

Scenario Videos

Two different videos were used to present the event participants were asked to recall. The videos were matched in content and quality. These videos depicted a young man as he sits down on a chair beside an unattended, open backpack. The man looks around before taking a laptop from the unattended bag and placing it in his own. He then looks around again before standing up and leaving. Each video featured different actors who closely resembled one another. Two
different actors were used in order to manipulate the target-presence or absence of the eyewitness lineup task. These videos were labeled Video A and Video B.

**Eyewitness Lineup**

A six-person eyewitness lineup containing five non-targets (aka fillers) and one target was used to test memory for the target. Fillers were matched in similarity to the individual who appeared in the lineup (i.e., the actor from Video A). All those in the lineup were matched on the same basic criteria (sex, ethnicity, skin tone, and approximate age and build). The lineup was presented simultaneously to all participants using clearly printed images in order to mimic a real-life lineup presentation as closely as possible. The lineup was constructed based on the single-lineup paradigm that was developed by Oriet and Fitzgerald (2018) to improve the ecological validity of eyewitness lineup identification tasks. The single-lineup paradigm uses one lineup for all participants and varies the event witnessed to manipulate the presence of the culprit. As this paradigm uses the same lineup for each condition, the innocence of the suspect in the lineup is determined by the video the participants will have previously watched (for reference, refer to Appendix E). Therefore, by using the same fillers and only choosing to include the actor from Video A in the lineup, the present study was able to manipulate the target-presence and target-absence of the lineup by determining which of the two videos the participants watched during the scenario phase.

**Procedures**

The data were collected at the RCMP Depot Division during a typical CTP training day. Troops participated one at a time in order to assess them at the same point in their CTP. Participants’ assignment to Exertion and Control groups was previously determined in order to run two troops through each of the conditions. The first two troops were Control groups and the
subsequent two were the Exertion groups. During their scheduled participation in the study, consent forms were read and signed, and the RPE scale was administered to all participants prior to their scheduled breakfast. This was done in order to establish a baseline measure of the cadets’ perception of physical exertion prior to engaging in any activities. Due to participation in other activities for their CTP (band practice) or illness, some participants completed only one of the two RPE scales (Exertion, $N = 3$, Control, $N = 4$). For participants in Group 2 (i.e., the Control condition), they then engaged in a 50-minute learning session. During this session, participants engaged in self-directed learning where they were advised not to engage in any activity in which they would physically exert themselves. Participants in Group 1 (i.e., the Exertion condition) then participated in a 50-minute physical activity training session. This session is a typical training component of the CTP schedule, and exerts the cadets to a similar degree as they would be exerted in the field as an RCMP officer. These particular training sessions involved Head and Arm Lock controls, including a warm up, drills, and a final culmination with the cadets exerting 100% concentrated effort. Following the completion of these tasks (i.e., control and exertion), participants had 15 minutes to arrive at their scheduled two-hour research session, where the second part of data collection occurred.

At the beginning of the scheduled research session, the RPE scale was administered for a second time to all participants in order to ensure that they were sufficiently exerted during their physical training session. Predetermined divisions within each condition (i.e., Exertion and Control groups) determined whether each troop would view Video A or Video B during the scenario phase of the study. This allowed for half of the cadets in the exertion group and half of the cadets in the control group to view Video A, and the other half to view Video B. These videos served as the stimuli for the eyewitness memory task. Each troop completed the
experiment as a group. Participants were instructed to choose a seat that was not adjacent to any other occupied seat. Participants were instructed to play close attention, and then watched the video randomly chosen for their group, which was displayed on a large screen using a video projector.

After watching either Video A or B, each troop listened to a 15-minute explanation of the role of the Research and Strategic Partnerships Unit at the RCMP, and its involvement in the CTP by one of the unit’s two research analysts. Cadets were seated for the duration of this presentation. This brief delay was introduced to prevent rehearsal of the videos that the participants had just seen, to ensure that recall performance was not at ceiling. Following this distractor task, all participants were presented with the same six-person simultaneous lineup. This lineup contained either the actor from Video A or B, as well as five fillers that match a description of the suspect. A randomization procedure was used to determine the placement of faces in the lineup. This procedure randomly selected Position 3 to contain the target in both lineups. The position of the target and each filler was therefore identical for all participants regardless of target presence.

Because half of the troops had seen Video A, and half had seen Video B, the target presence of the lineup was determined by a combination of which video actor they had viewed, and which lineup they were shown. Using the single-lineup paradigm increased the ecological validity of this task because it closely mimicked a real-life situation wherein police investigators only construct one lineup with known-innocent fillers presented alongside a single suspect, whose guilt or innocence is unknown to the investigator at the time of constructing the lineup. Participants were told that the actor from the video may or may not be present in the lineup, and, if the actor is present, to identify him from the lineup. The participants’ response (suspect, filler,
or lineup rejection) was recorded on response sheets with selection options in a different randomized order (i.e., Person 1, Person 2, Person 3, Person 4, Person 5, Person 6, Not Present) for each participant (Appendix F). Participants were informed of this randomized order. This was done in order to make it more difficult for participants to see the answers provided by other cadets, and to ensure that their answer was a true reflection of their own interpretation of the lineup. Regardless of target presence, the suspect was labeled Person 3 to maintain the physical location of their image in the lineup. Following their participation, all participants were provided with a debriefing that indicated the reason behind their involvement, as well as details about the confidentiality of their data (see Appendix G).

Results

In order to interpret the effects of exertion on suspect identification in target present and target absent lineups, a 2 (Group: Exertion or Control) x 2 (Condition: Target-Present or Target-Absent) x 2 (Response: Correct or Incorrect) Hierarchical Loglinear Regression Analysis (HILOG) was conducted.

To confirm that participants in the Exertion condition were exerted more than those in the control condition, a 2 (Condition: Exerted, Control) x 2 (RPE Score: Time 1, Time 2) mixed model ANOVA was run to determine whether the mean scores between RPE scale ratings differed at Time 1 and Time 2 as a function of condition. The results showed a significant between-subjects effect for the Condition variable, $F(1, 109) = 76.477$, $MSE = 501.093$, $p < .001$, suggesting that there was a significant difference in RPE scores between conditions. RPE scores in the Exertion condition ($\mu = 9.60$, $SE = .25$) were higher than in the Control condition ($\mu = 6.58$, $SE = .23$). Findings also suggested a significant within-subjects effect for the RPE score variable, $F(1, 109) = 45.772$, $MSE = 156.960$, $p < .001$, indicating a significant difference
between scores at Time 1 and Time 2. RPE scores at time 2 ($\mu = 8.93, SE = .22$) were higher than scores at Time 1 ($\mu = 7.25, SE = .21$). RPE scores at Time 2 for the Exertion condition ($\mu = 11.24, SE = .32$) were higher than RPE scores at Time 2 for the Control condition ($\mu = 6.63, SE = .30$). Participants in the Exertion condition experienced a greater increase in overall feelings of exertion ($\mu_{\text{diff}} = 3.27$) between Time 1 and Time 2 than those in the control condition ($\mu_{\text{diff}} = .10$) experienced between Time 1 and Time 2. A significant interaction was found between RPE scores at Time 1 and Time 2 with respect to condition assignment, $F(1,109) = 40.507$, $MSE = 138.906$, $p < .001$, confirming that the Exertion condition experienced significantly greater feelings of physical exertion at Time 2 (Appendix H).

The HILOG revealed that the test of a model retaining the highest order interaction (i.e., a three-way interaction between all variables) was not significant, $\chi^2(1) = .000$, $p = .993$, indicating that the model including all main effects and interactions was not a good fit with the data and, therefore, this model was not investigated any further. Removing two-way and higher order effects significantly reduced the fit of the model, $\chi^2(4) = 15.155$, $p = .004$, suggesting that a combination of main effects and two-way interactions is required in order to explain performance. When removing strictly the main effects, there is no significant change to the model, $\chi^2(3) = 2.148$, $p = .542$. This was repeated for two-way interactions, however the removal of all two-way interactions significantly reduced the fit of the model, $\chi^2(3) = 15.155$, $p = .002$.

A step summary was used to determine the fit of the model with selected terms removed. Because the three-way interaction is not significant, the two-way interactions were examined next. First, the inclusion of the interaction between exertion and target presence did not improve the fit of the model, $\chi^2(1) = .020$, $p = .887$. The two-way interaction between exertion and suspect identification was found to be significant, $\chi^2(1) = 4.643$, $p = .031$, as well as the
interaction between target presence and suspect identification, $x^2(1) = 10.003$, $p = .002$, so these terms were retained. The best-fitting model therefore consisted of the three main effects and the two two-way interactions involving suspect identification.

Where applicable, all pairwise associations are carried out with alpha=.05, two-tailed. Partial association revealed a significant relationship between target presence and suspect identifications, $x^2(1) = 10.003$, $p = .002$. Participants were more likely to identify the suspect in a target present lineup (61.1%) compared to a target absent lineup (31.7%, $z = 2.14$, $p = .032$). Suspect identification types were further divided into three categories: suspect (i.e., identification of the target when the video contained the person in the lineup and identification of the innocent suspect when the video contained a similarity-matched foil to the suspect in the lineup), filler (i.e., identification of another person in the lineup), and rejection (i.e., rejecting the lineup). Participants were not significantly more likely to make a filler selection when the target was absent (34.9%) than when the target was present (20.4%, $z = 0.88$, $p = .378$). Participants were also not significantly more likely to reject the lineup when the target was absent (33.3%) than when the target was present (18.5%, $z = 0.89$, $p = .38$). There was, however, a significant relationship between target presence and suspect identification type, $x^2(2) = 10.126$, $p = .006$.

Partial association revealed a significant relationship between exertion and suspect identifications. Participants were more likely to make a suspect identification when they were not exerted (54.8%) than when they were exerted, although this difference did not reach significance (34.5%, $z = 1.43$, $p = .152$). Participants were more likely to identify a filler or reject the lineup when exerted (65.5%) than when not exerted, a difference that approached significance (45.2%, $z = 1.62$, $p = .104$). Suspect identification types were again divided further into three categories: suspect (i.e., identification of the target when present and identification of the similarity-matched
foil when absent), filler (i.e., identification of another person in the lineup), and rejection (i.e., rejecting the lineup). Participants were no more likely to make a filler identification when they were exerted (30.9%) than when they were not exerted (29.8%, $z = 0.07, p = .47$). Participants were also no more likely to reject the lineup when they were exerted (34.5%) than when they were not exerted (19.4%, $z = 0.92, p = .18$) (Appendix I). The interaction between suspect identification types and exertion was not significant, $x^2(2) = 5.457, p = .065$ (Appendix J).

**Discussion**

These results supported my hypothesis that non-exerted participants would be more accurate in correctly identifying the culprit from a target present lineup. This echoed Hope et al.'s (2012) findings suggesting that participants who were physically exerted were less accurate in correctly identifying the critical target in target present lineups. The present study replicated Hope et al.'s findings, and suggested that physically exerted participants make more filler identifications than those in the control condition when viewing a target present lineup. Taken together, these results are consistent with their conclusion that exertion reduces memory accuracy.

Different from Hope et al., our study introduced a target absent lineup to determine if exertion would also increase misremembering. These results did not support the hypothesis that physically exerted participants would be less accurate in correctly rejecting the target absent lineup. Physically exerted participants were in fact more likely to reject the lineup than those who were not physically exerted. Similarly, those who were not physically exerted made incorrect suspect identifications in target absent lineups more frequently than those who were exerted, although there was not sufficient power to detect a significant difference in this condition.
The use of the single-lineup paradigm did not explain any differences between this work and that of Hope et al. because the target present condition of the single-lineup paradigm is identical to the target present condition in Hope et al.’s study, which did not test a target absent condition. However, the use of the single-lineup paradigm did increase the ecological validity of our results, and eliminated variations in lineup construction. In manipulating which video the participants were shown to determine target presence, we can be certain that our results were due to factors other than lineup construction.

The results of the present study were consistent with findings reported in previous literature that suggest physical exertion has a negative impact on cognitive performance. Giles et al. (2019) identified the combination of high-intensity exercise and cognitive task difficulty as particularly vulnerable to these negative implications. My results provide tentative support for their hypothesis as they demonstrate the negative implications of physical exertion (i.e., high-intensity exercise) on higher-level cognitive processing tasks (i.e., recognition memory for faces) because physically exerted participants were less accurate in correctly identifying a culprit from a target present lineup.

However, participants in the exertion condition made fewer false identifications and were more accurate in correctly rejecting the target absent lineup than participants in the control condition. This could potentially be explained by assuming that individuals that are exerted are more conservative in their judgements. If so, this would suggest that exertion is not necessarily impairing participants’ memory for the event they observed, but instead causes them to feel less confident in their ability to recall the person from the video. This could explain the finding of a reduced number of hits for exerted participants accompanied by a reduced number of misidentifications. Therefore, it is possible that exertion could have affected the metamemory
(i.e., people’s beliefs about the accuracy of their own memory) of exerted participants, rather than their recognition memory *per se*. However, if this account is correct, exerted participants should have made fewer filler identifications than non-exerted participants in the target absent condition, which was not observed. Thus, consideration of both memory accuracy and confidence in memory may be needed to fully account for the observed pattern of results.

**Limitations and Future Directions**

The present study was limited by certain factors. Because the primary interest was in developing a greater understanding of the effects of eyewitness lineup identification among police officers, it may have been beneficial to have a population of RCMP members rather than cadets. Similarly, due to their minimal field experience, and current position in the CTP, it is possible that graduated members would have had more accurate responses, and would have been a better reflection of the population we wanted to address.

Another possible limitation includes the amount of time that passed between the physical exertion and cognitive tasks. In a real-life situation, it is likely that a police officer would be exposed to the target while they were actively exerted. However, there was a minimum 15-minute time period between the exertion task and the presentation of the target identity. Future research could consider exposing cadets to the target while they are engaging in the physical exertion task to more closely resemble a real-life scenario. Similarly, a real-life scenario in which a police officer is physically exerted would most likely simultaneously increase their levels of stress. As previous research has suggested, the implications of high-stress situations can also negatively impact the ability to accurately identify a suspect from a target present lineup. Future research could consider including an additional stress variable to explore the potential positive correlation between stress, exertion, and accuracy.
As previously suggested, metamemory could explain the unexpected decrease in suspect identifications and false alarms that was observed in exerted participants. Future research could include a confidence rating to account for its influence on lineup identifications in both exerted and non-exerted police officers.

Data collection was limited by the Covid-19 pandemic. This reduced the number of cadets that were able to participate in the research. As a result, the present study did not have as much statistical power as was initially intended.
References


Appendix A

Certificate of Ethics Approval

[Research Ethics Board Certificate of Approval]

PRINCIPAL INVESTIGATOR: Dr. Chris Oriet  
DEPARTMENT: Department of Psychology  
REB#: 2019-217

TITLE: The Effects of Physical Exertion on Eyewitness Identification among RCMP Cadets

APPROVED ON: January 31, 2020  
RENEWAL DATE: January 31, 2021

APPROVAL OF:  
- Application for Behavioural Research Ethics Review  
- Invitation to Participate – Depot  
- Invitation to Participate – Participants  
- Debriefing Form  
- The Borg Rated Perceived Exertion  
- Co-Supervision Agreement  
- RCMP letter of approval

Full Board Meeting: [ ]  
Delegated Review: [x]

The University of Regina Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol, or related documents.

Any significant changes to your proposed method, procedures or related documents should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS  
In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month of the current expiry date each year the study remains open, and upon study completion. Please refer to the following website for the renewal and closure forms:  
https://www.uregina.ca/research/for-faculty-staff/ethics-compliance/human/ethicsforms.html

Chris Street PhD  
REB Chair  
University of Regina

Please send all correspondence to:  
Research Office  
University of Regina  
Research and Innovation Centre 109  
Regina, SK S4S 0A2  
Telephone: (306) 585-4775  
Fax: (306) 585-4893  
research.ethics@uregina.ca
Appendix B

Invitation to Participate (Participants)

To: Potential Participants
Subject Line: Research Opportunity for Cadets

My name is Asia Libke and I am an Honours student in the Department of Psychology at the University of Regina under the academic supervision of Dr. Chris Oriet and Tansi Summerfield. I am seeking participants for my Honours Thesis research project investigating the effects of physical exertion on cognitive tasks among RCMP cadets.

This invitation was sent to you by your training facilitator on my behalf. I would like to make it known that you are in no way obligated to participate in this research. Furthermore, none of your training facilitators will be informed of your decision to participate or not participate.

Participants in this study will be asked to partake in a cognitive task and will be exposed to potentially stressful stimuli. Participation will take approximately two hours of the participants’ time. During this time, participants will complete two short questionnaires, be exposed to potentially stressful stimuli, and will be asked to complete a cognitive task. All data will be collected on paper, and safely transported to and stored at the University of Regina, without any identifying information connected to the data (e.g., name, HRMIS number).

Please note that there are no anticipated risks associated with your participation in this research project. Your performance in the research and the subsequent data will be confidential and none of your data nor your performance in the research project will be used to determine individual performance for your cadet training. Data will not be shared with training facilitators or anyone else outside of the research project (investigators are listed below). No identifying information will be stored with your responses, and therefore cannot be linked to you as an individual.

This project is pending approval on ethical grounds by the Research Ethics Board, University of Regina. If research participants have any questions or concerns about their rights or treatment as participants, they may contact the Chair of the Research Ethics Board at (306) 585-4775 or by email: research.ethics@uregina.ca

If you would like to participate in this study, please inform me by e-mail.

Thank you,

Asia Libke
Researchers:

Asia Libke  
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Tansi Summerfield, M.A.  
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S4S 0A2  
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Email: summerft@uregina.ca
Appendix C

Participant Consent Form

**Project Title:** The Effects of Physical Exertion on Cognitive Processes among RCMP Cadets

**Researcher:** Asia Libke, Undergraduate Student, Department of Psychology, University of Regina, (306) 585-5339, libke20a@uregina.ca

**Supervisors:** Dr. Chris Oriet, Faculty, Department of Psychology, University of Regina, (306) 585-4193, chris.oriet@uregina.ca.

Tansi Summerfield, Graduate Student and Research Assistant with the Royal Canadian Mounted Police, Department of Psychology and Research and Training Innovation Unit, University of Regina, summerft@uregina.ca

**Purpose and Objectives of the Research:**
This project will investigate the effects of physical exertion on cognitive processes in police officers. To do so, we will observe the impact of physical exertion on performance during a brief cognitive task among RCMP cadets.

**Procedures:**
- Our research will be conducted at the RCMP Depot Division in Regina, Saskatchewan. The time needed to participate in our study will be consistent with the regular training commitments of RCMP cadet training. In line with standard RCMP physical training exercises, participants will engage in a physical exertion task to fatigue them to a similar degree that RCMP officers are fatigued in the field. To measure their degree of physical exertion, participants will fill out the Rated Perceived Exertion (RPE) self-report measure before and after engaging in physical activity. Participants will then view a video of an emotionally charged event and answer a few questions about the video to assess the impact of exertion on performance of a cognitive task.
- Please feel free to ask any questions regarding the procedures and goals of the study or your role.

**Potential Risks:**
- The risks to you associated with participating in this study are no greater than those encountered in your daily activities of participation in your regular RCMP Cadet Training Program (CTP). You may be sore from participating in the physical exertion procedure, but not more than in any other training session in the CTP. There are no known or anticipated emotional, social, psychological, physical, or economic risks to you by participating in this research.
- If in the opinion of the CTP facilitators you are unable to attend the subsequent session, (e.g. injury during the first session or other superseding CTP requirements) your participation will be discontinued.
Potential Benefits:
- The benefits of the research are that it furthers our understanding of the factors that can have an impact on RCMP officers’ performance of a cognitive task. Your participation will help in addressing challenges faced by police officers who are more likely than average to be subjected to stressful and physically demanding events and still be expected to perform at an optimal level.

Confidentiality:
- Ultimately your performance in the research and the subsequent data will be completely confidential and will not be linked to you as an individual as your data will be re-coded under anonymous participation numbers. Your data and performance in the research project will not be used in the training program for performance reviews and your data will not be shared with training instructors, supervising officers, or anyone else outside of the research project.
- **Storage of Data:**
  - Your name will not be able to be linked to the raw data you provide. These data will be stored in a locked file cabinet in a locked laboratory (RI 115) at the University of Regina.
  - Signed consent forms will be shredded after five years.

Right to Withdraw:
- Your participation in the research project is voluntary and you have the right to withdraw from the research project at any point during the collection of data. Moreover, once the data is collected, you will have seven days from collection date to withdraw from the study and have your data removed from the project. After this seven-day period, your data will be aggregated with the data provided by all other participants, therefore it will no longer be possible to identify and remove your data from the aggregated data set.
- Whether you choose to withdraw or not will have no effect on your standing in the program or how you will be treated.

Follow up:
- To obtain results from the study, please contact either the researchers or supervisors for a copy of the findings once they are disseminated.

Questions or Concerns:
- Contact the researcher(s) using the information at the top of page 1;
- This project has been approved on ethical grounds by the U of R Research Ethics Board on January 31st, 2020. Any questions regarding your rights as a participant may be addressed to the committee at ((306) 585-4775 or research.ethics@uregina.ca). Out of town participants may call collect.

SIGNED CONSENT
Your signature below indicates that you have read and understand the description provided; I have had an opportunity to ask questions and my/our questions have been answered. I consent to participate in the research project. A copy of this Consent Form has been given to me for my records.
Name of Participant ____________________ Signature ____________________ Date ____________________

Researchers Signature ____________________ Date ____________________

A copy of this consent will be left with you, and a copy will be taken by the researcher.
Appendix D

Rated Perceived Exertion Scale

The Borg Rated Perceived Exertion (RPE) Scale

How to Use the RPE:
- Circle the number rating that most accurately represents your overall feelings of physical exertion.
- While you’re filling out the RPE, think about your overall feelings of physical effort and fatigue. Don’t focus on any single things, like leg pain or shortness of breath. Try to concentrate on your total, inner feeling of exertion.
- Find the best description of your level of effort from the examples on the right side of the table.

<table>
<thead>
<tr>
<th>Number Rating</th>
<th>Verbal Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>No effort at all (e.g. Sitting and doing nothing)</td>
</tr>
<tr>
<td>7</td>
<td>Very, very light (e.g. Your effort is just noticeable)</td>
</tr>
<tr>
<td>8</td>
<td>Light effort</td>
</tr>
<tr>
<td>9</td>
<td>Very light (e.g. Walking slowly at your own pace)</td>
</tr>
<tr>
<td>10</td>
<td>Light effort</td>
</tr>
<tr>
<td>11</td>
<td>Fairly light (e.g. Still feels like you have enough energy to continue exercising)</td>
</tr>
<tr>
<td>12</td>
<td>Light exercise</td>
</tr>
<tr>
<td>13</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>14</td>
<td>Strong effort needed</td>
</tr>
<tr>
<td>15</td>
<td>Hard</td>
</tr>
<tr>
<td>16</td>
<td>Very strong effort needed</td>
</tr>
<tr>
<td>17</td>
<td>Very hard</td>
</tr>
<tr>
<td>18</td>
<td>Very, very hard (e.g. For most people, this is the most strenuous exercise they have ever done. Almost maximal effort.)</td>
</tr>
<tr>
<td>19</td>
<td>Exhaustion (e.g. Absolute maximal effort (highest possible))</td>
</tr>
</tbody>
</table>
Appendix E

Procedures: Single-Lineup Paradigm

This illustrates which video the participants were shown (Video A or B), and which actor was included in the eyewitness lineup. The lineup always contained the actor from Video A, however, their position in the lineup was randomized.
### Appendix F

Response Cards

<table>
<thead>
<tr>
<th>ID: _______________</th>
<th>Age: _____</th>
<th>Sex: F / M</th>
<th>Date: _____ / _____ / 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Person 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Not present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Person 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Person 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Person 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Person 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Person 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix G

Debriefing Form

DEBRIEFING FORM

The Effect of Physical Exertion on Eyewitness Identification among RCMP Cadets

Investigators: Asia Libke (306-209-9937), Dr. Chris Oriet (306-585-4193), & Tansi Summerfield (306-530-3687)

It is imperative that you do not discuss the research with anyone who has not participated in the project – Any discussions with outside parties will compromise the integrity of the research.

The purpose of this study is to investigate whether physical exertion has an impact on eyewitness identification. Physical exertion was measured by the Rated Perceived Exertion Scale, where you selected the number on the scale that best expressed your perception of physical exertion. We will use your responses on this task as a measure of your physical exertion.

The eyewitness identification task was our measurement of your cognitive performance with regard to your memory for faces. Some participants were shown a target-present lineup which included the actor from the video they were shown, and some were shown a target-absent lineup which did not include the actor from the video they were shown. The responses to the lineup shown was recorded on paper and will be used for later analyses in the project.

All information and data received is confidential. All data will be destroyed once it has been entered into a data file. No individual data will be shared with anyone other than the research investigators. Seven days following your participation, the record linking your name and participant number will be permanently deleted.

Withdrawal from this study is still possible, if you would like your data to be removed from this project you have seven days from today to contact myself or another investigator. Upon doing so, you will receive a letter of confirmation that your data was removed from the project. The deadline to withdraw your data is __________.

This research was conducted in partial fulfillment of my Honours Thesis through the University of Regina. The data from this project will be included in my Honours Thesis (written document). There is a potential for this research to be presented at conferences and/or submitted in journals. In any and all of these disseminations your confidentiality will remain intact and no one will be able to link participation and/or performance to you.

If you have any questions or concerns regarding the research, you can contact me or one of the other investigators involved in the project (see contact information below). If you are interested in a summary of the results when the research has concluded, please contact Asia Libke.
Thank you for your participation,

Asia Libke

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Appendix H

Results from Mixed-Model ANOVA

These are the results of the mixed-model ANOVA; illustrating the significant difference in RPE scores at Time 1 and Time 2 as a function of Exertion.
Appendix I

Exertion x Suspect Identification Type

This illustrates the graphed results of the interaction between Exertion and Suspect Identification Types (i.e. Suspect, Filler, Rejection).
Appendix J

Target Presence x Exertion x Suspect Identification Type

This illustrates the graphed results of the interaction between Target Presence, Exertion, and Suspect Identification Types (i.e., Suspect, Filler, Rejection).