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The Impact of Shared Attention on Multiple Object Tracking in Competitive and Cooperative Settings

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I am submitting herewith a thesis written by Sydney Blaine Michelson entitled "The Impact of Shared Attention on Multiple Object Tracking in Competitive and Cooperative Settings." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

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The Impact of Shared Attention on Multiple Object Tracking in Competitive and Cooperative Settings

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ABSTRACT

Shared attention theory postulates that when simultaneously co-attending to a stimulus with a similar other, cognitive prioritization occurs that has both psychological and behavioral impact, with the ultimate goal of generating collective knowledge. A cooperative scenario occurs when a group's goal is linked such that one person's success is also another's. By contrast, a competitive scenario occurs when a group's goal is linked such that if one person succeeds, the other fails. The purpose of this thesis was to understand the effect of cooperative and competitive settings on shared attention in a performance domain. I hypothesized that cooperation would moderate the effect of shared attention on performance, such that during synchronous co-attention, a cooperative scenario (versus a competitive one) would increase and improve shared attention's influence on performance. This relationship was investigated in a study with 152 undergraduate participants, but the expected relationship was not found. There were no differences between groups in terms of performance on a multiple object tracking task. Subjective experience results are also discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1. Introduction

Humans experience the world with one another, often in cooperative or competitive settings, in a constantly changing visual environment. Whether we are, for example, playing a competitive videogame with a close friend or collaborating on a work project, there are countless plausible naturalistic situations in which we are simultaneously attending to a stimulus in a cooperative or a competitive scenario. Shared attention theory, or the idea of synchronous co-attention with a similar other, posits that sharing attention leads to cognitive prioritization due to its promotion of social coordination (Shteynberg, 2015). In social contexts where shared attention is not likely (i.e. competitive scenarios), the impact of synchronous co-attention could potentially diminish. Conversely, in cooperative social situations, shared attention theory suggests an increased impact because social coordination is likely. Consequently, the major research question then follows: how does a cooperative or a competitive mindset influence the effect of shared attention on performance? Manipulating a cooperative or competitive social setting to identify the effects of shared attention in a performance domain was the primary undertaking for this thesis.

COOPERATION AND COMPETITION

In many contexts, people want or need to work with other humans in order to accomplish a goal; other times, it is best to compete against one another in an individualistic manner to reach an objective. For example, we may be competitive in our economic endeavors but cooperative in our family life; however, everyone experiences both cooperative and competitive scenarios on a frequent basis.

Of primary interest is understanding the effects of a cooperative or competitive goal on shared attention in a performance domain. It is first important to understand how I defined

cooperation and competition for the purposes of this project. In Deutsch's (2006) theory of cooperation and competition, basic types of goal interdependence are discussed, such that both positive and negative goal interdependence exist. In general, goal interdependence occurs when outcomes of individuals are affected by both their own and by each other's actions (Deutsch, 2006). In positive goal interdependence, goals are positively correlated in such a way that if one person is successful in his or her goal, another person is also successful in his or her goal (Deutsch, 2006). This leads to the process of cooperation, which was defined by Deutsch (1949) as a group working together to attain a common goal. In this context, individuals can reach their goals if those with whom they are cooperatively linked also reach their goals (Deutsch, 2006). In these situations, there is a heightened prominence of alikeness and involvement, with a hypothesized sense of similarity in both inclusion and values (Deutsch, 2006). Further, in sociological research, Merrill (1965) defined cooperation as a type of social interaction where two or more people work together to attain a common goal. Even from the Latin root words of cooperation, with "co" meaning together and "operari" meaning to work, we see that definitions of cooperation will include some form of success as a unit with goal attainment for all those involved. Deutsch (1949) and much elaborated by Johnson & Johnson (1989) hypothesize more positive characteristics coming from cooperation, including but not limited to: more effective communication, friendliness and helpfulness, and increased productivity and coordination.

Conversely, with negative goal interdependence, goals are negatively correlated such that one person's goal attainment decreases another person's goal attainment; if one person succeeds, the other person fails or vice versa (Deutsch, 1949, 2006). In essence, individuals obstruct each other's efforts to achieve their goals (Deutsch, 2006). This leads to the experience of competition, which was defined by Kelley and Thiabut (1969) as one person trying to

outperform another in a zero-sum situation. In a similar vein, Doob (1952) understood competition to be a context in which a goal is considered scarce and unable to be shared or seems unable to be shared (Griffin-Pierson, 1990). Stockdale, Galejs, and Wolins (1983) saw competition as a situation in which everyone who does not win is excluded from goal achievement. In these competitive experiences, the differentiation of the self from the competing other is made salient. As Griffin-Pierson (1990) interestingly pointed out, all of the mentioned competition definitions involve the sense of winning against another or doing better than an opponent. In addition, Deutsch (1949, 2006) and Johnson and Johnson (1989) have hypothesized seemingly negative consequences and outcomes associated with competition: impaired communication, an obstructing of efforts and lack of helpfulness, as well as attempts to enhance one's own power while reducing other's power.

It is also important to note that Deutsch discussed the idea that sometimes there is no goal interdependence, which is an individualistic situation that occurs when there is no correlation between goal attainment and people achieving goals (Deutsch, 1949). He further made it clear that positive and negative goal interdependence are not always clear-cut and distinctive scenarios, but often overlap and are intertwined with one another (Deutsch, 2006).

SHARED ATTENTION

People experience life together. It is typical to share these experiences regularly, and across varied sensory modalities, whether that be sight, sound, smell, taste, or touch (Shteynberg, 2015). According to Shteynberg's (2015) cumulative research on shared attention theory, the shared attention state, or the perception that "we are attending" to some stimulus together, demonstrates a unique psychological experience that underlies the affective, cognitive, and behavioral consequences of shared attention (see figure 1). The theory argues that humans are

constantly tasked with choosing which incoming stimuli to prioritize due to limited processing resources, so shared attention may provide a helpful context to understand the mechanism that aids in these choices. With this in mind, the shared attention state is illuminated when two necessary conditions are met. First, there must be a relationally close other or others present, and this presence can be real or imagined; this person should be someone who an individual sees as similar to himself or herself on some level and could plausibly be considered a member of the individual's ingroup. Because future interaction and working with this type of person is likely, it would be advantageous for individuals to be on the same page as their other group members. Second, this co-attention to some aspect of the world must occur at the same time, or simultaneously, with the relationally close other(s). The idea that the co-attention occurs synchronously makes shared attention likely to occur for all observers. When these two conditions are met, the shared attention state emerges, which is characterized as the perception that "we are attending" to some aspect of the world together, where cognitive resources are focused on the same target at the same time with a similar other (Shteynberg, 2015).

Evidence of the impact of the shared attention state leading to greater cognitive resources toward the focus of shared attention and thus psychological and behavioral consequences has substantial empirical evidence (Shteynberg, 2015, 2018). In terms of memory and shared attention theory, when there is more cognitive emphasis and prioritization on a shared experience or stimulus, the object of shared attention should be more easily recalled. Studies have found this exact effect both directly and indirectly, with participants who believed they co-attended with a similar other having both faster and more accurate memory of words and images (Shteynberg, 2010; He et al., 2011). Shared attention theory also expects that the increased cognitive processing leads to stronger motivation, depicted by greater goal completion and persistence

when done simultaneously with a similar other. This impact of shared attention has been seen in both promotion and prevention signal-detection tasks (Shteynberg & Galinsky, 2011) as well as math puzzles (Walton et al., 2012).

Another domain with evidence of shared attention theory is that of judgment, with shared attention leading to a more extreme judgment of a given object (Shteynberg, Hirsh, Apfelbaum, et al., 2014). Again, there is both direct and indirect evidence of this effect. A study including judgments of neutral paintings found judgments to be more congruent with baseline mood (Shteynberg, Hirsh, Galinsky, & Knight, 2014). Indirect evidence has also been seen via taste judgment studies that did not have a direct manipulation of relational closeness, but social connections could have been formed during the duration of the study; pleasant tasting chocolate was rated with more liking and unpleasant tasting chocolate was rated with more dislike when alongside a similar other (Boothby et al., 2014). Similarly, shared attention theorizes an impact on emotional experiences such that positive stimuli should feel more positive and negative stimuli should feel more negative; evidence of this has been seen with simultaneous co-attention to happy images and videos and sad images and videos leading to more happiness and unhappiness, respectively (Shteynberg, Hirsh Apfelbaum et al., 2014). Finally, shared attention theory postulates that observed behavior should lead to greater adoption of behavior and thus increased behavioral learning. Evidence for this effect was seen in Shteynberg and Apfelbaum (2013), where greater behavioral adoption of written form (e.g. paragraph or chat) emerged when simultaneously co-attending with a similar other. As evidenced here, the shared attention state has a clear impact on many psychological domains.

Generating collective knowledge within a group upon the presentation of novel information is the overarching purpose of shared attention theory, leading to more easily facilitated ingroup coordination. Humans are an inherently group-focused species; having a basic foundation of common knowledge with others with whom you are close to and often interact with is important for the betterment and success of the group (Shteynberg, 2015). According to shared attention theory, overlapping knowledge is important in an evolutionary sense, in that humans need common knowledge for better communication as well as for being understood.

This generation of collective knowledge takes place with the increased devotion of cognitive resources on the focus of shared attention during the shared attention state, that "we are attending to X," due to increased relevance of the object (Shteynberg, 2015). This leads to deeper and more extensive cognitive processing, with the object of shared attention receiving more cognitive prioritization of that information (Shteynberg, 2018). Shared attention could then potentially serve as a preparatory mechanism for cooperation based on this collective knowledge.

In considering shared attention in the context of cooperative or competitive scenarios, by manipulating both goal type (competitive or cooperative) as well as timing (synchronous or asynchronous), one is able to assess how these contexts influence the effects of shared attention. Based on the logic of shared attention, it would follow that a cooperative setting could lead to an increased sense of collaboration and feeling of "we" under the shared attention state, leading to even more devotion of cognitive resources and cognitive prioritization, which could increase performance. Another possibility is that a cooperative scenario could prime participants towards a feeling that there may be future communication with the similar other, which could also increase the cognitive prioritization and thus increase performance. By contrast, a competitive

scenario could weaken or diminish the "we" feeling during a shared experience, thereby decreasing cognitive resources and potentially weakening performance. Another possibility is that the feelings of competition may make participants feel as though they are not going to communicate or cooperate in the future, which would have the same diminished effects on performance.

HYPOTHESIS

In order to make things as clear as possible, my hypothesis states that cooperation will moderate the effect of shared attention on performance, such that during synchronous co-attention, a cooperative scenario (versus a competitive one) will increase and improve shared attention's influence on performance.

ALTERNATIVE POSSIBILITIES

In contrast to the shared attention perspective, some have implied that the effect of shared attention is really just the effect of the competitive nature of individuals, so adequately deciphering cooperation and competition in shared and non-shared attention contexts may help to address this concern. Especially in the West, there is the presence of an individualistic culture, where the individual is valued over the group (Markus & Kitayama, 1991). This emphasis on independence and uniqueness in Western culture could lend itself to individuals putting more effort into competitive scenarios where they can win and be seen as "better." This framework can also be seen through the lens of social comparison theory. Festinger (1954) developed the idea that humans have an inherent need to evaluate their abilities, and they do so through comparing their abilities to the abilities of others who are similar. Given that there is an immense range of possible people with whom one can compare himself or herself to, social comparison theory states that a person will choose someone who has similar abilities or opinions to compare him or

herself to, as opposed to someone who has different abilities or opinions (Festinger, 1954). This is especially true for individuals in Western cultures, where different performances have different values, and the better success there is on a performance, the more desirable it is considered (Festinger, 1954). These constant comparisons can lead to a competitive nature among similar individuals, with a unidirectional value placed on better performance, at least in Western cultures (Festinger, 1954). Said differently, improving personal performance in a competitive way is of importance in Western cultures. How might this framework alter our current hypothesis?

ALTERNATIVE MECHANISMS

Utilizing the logic of social comparison theory when considering synchronous and asynchronous co-attention, synchronous co-attention to a performance task could signal competition to participants, feeling a greater sense of social comparison with a similar other sitting next to him or her. In this scenario, competition could augment performance when synchronously co-attending to a performance task. A cooperative scenario may hinder the strong feelings of social comparison, as individuals could feel that they are more of a team or collaborative unit rather than feeling they need to prove their uniqueness and ability. In this case, cooperation could diminish performance under synchronous co-attention.

ALTERNATIVE HYPOTHESIS

Again, to be explicitly clear, in this case, competition would moderate the effect of shared attention on performance, such that a competitive scenario (versus a cooperative one) will increase social comparison and improve performance on a multiple object tracking task.

MULTIPLE OBJECT TRACKING

As humans experience the visual aspects of life, the environment is constantly changing over time. In many situations, such as driving a car, it is essential to keep track of independent objects moving in the visual field over time. To simulate this real-world naturalistic experience of dynamic visual attention within the laboratory, the multiple object tracking paradigm (MOT) is often utilized (Pylyshyn & Storm, 1988). This is the paradigm that was used to test performance as the dependent variable for this thesis.

Although there are variations of the MOT paradigm that have been utilized and studied within the literature, the basic set-up is similar across MOT experiments (Meyerhoff, Papenmeier, & Huff, 2018). To start, there are several (usually about six to ten) objects (usually circles) that are visually indistinguishable from one another on the screen (Meyerhoff, Papenmeier, & Huff, 2018). Next, a smaller portion (usually three to five) of these objects are marked as target objects. As the objects move, participants in the experiments are instructed to track the subset of objects, also known as the targets, while they move for a set amount of time (Meyerhoff, Papenmeier, & Huff, 2018). The speed of the object as well as the motion path of the object is variable across studies and research questions (Meyerhoff, Papenmeier, & Huff, 2018). Following the trial, the performance of the participant is usually measured via a probe-one or a mark-all procedure. In the probe-one procedure, one of the objects is probed, and participants are asked whether a specific object was a target or not (Meyerhoff, Papenmeier, & Huff, 2018). In contrast, with a mark-all procedure, participants would be asked to mark all of the targets that they tracked and guess the other target objects (Meyerhoff, Papenmeier, & Huff, 2018). For the purposes of this experiment, the probe-one procedure is more important for understanding, as this was used in our experimental set-up.

With this basic set-up in mind, it is important to note that there are certain variables that can have an impact on tracking abilities, including a decrease in MOT performance with an increase in a number of variables including, but not limited to: number of targets (e.g. Alvarez & Franconeri, 2007; Drew, Horowitz, Wolfe, & Vogel, 2011; Phylyshyn & Storm, 1988), number of distractors (e.g. Bettencourt & Somers, 2009; Sears and Pylyshyn, 2000), trial duration (e.g. Oksama & Hyönä, 2004), and speed of the objects (e.g. Holcombe & Chen, 2012; Tombu & Seiffert, 2011).

How are humans able to accomplish multiple object tracking successfully? Varied theoretical frameworks exist that contribute to different parts of the overall process (Srivastava & Vul, 2016). No one theory can fully explain MOT, so ideas from many theories are relevant (Srivastava & Vul, 2016). The first comes from Pylyshyn's FINST theory, short for Fingers of Instantiation, in which people are understood to assign "pointers" to certain objects and then track them via a preconceptual mechanism that provides reference to objects in the MOT task (Pylyshyn, 1989). He argued that there is a disconnect between the task of indexing an object and attending to said object, thus making the mechanism preconceptual. Pylyshyn (1989) believed that there was a pre-existing finite number of "pointers," about four or five assigned as needed, and they "stick" onto certain moving objects. Based on this idea, other researchers predict that there is a limited capacity constraint on the number of targets that individuals are able to track, with perfect tracking up to the available number of "pointers" and then a collapse in tracking exceeding the available number (Srivastava & Vul, 2016).

While the FINST theory imposes fixed constraints allocated to tracked objects, other theoretical frameworks propose a more flexible allocation of attentional resources based on other variables (Meyerhoff, Papenmeier, & Huff, 2017). For example, cognitive resource models argue

that the capacity constraint is actually gradual rather than steep because there is accurate tracking at sufficiently slow speeds (Alvarez & Franconeri, 2007), but at high speeds, even one or two objects are seemingly impossible to track (Holcombe & Chen, 2012). Errors occur when attentional resources are too little to cover demands of the targets (Meyerhoff, Papenmeier, & Huff, 2017). Further, as previously mentioned, objects that move for a longer interval are harder to track even at constant speeds (Oksama & Hyöná, 2004), and a crowded spatial area impedes tracking (Franconceri, Lin, Pylyshyn, Fisher, & Enns, 2008). This has led to the theory that MOT difficulties are due to the distance the objects have to travel, with longer distance increasing identification error rates (Franconeri, Jonathan, & Scimeca, 2010).

There are certainly other theoretical understandings and frameworks for understanding and explaining MOT findings, but this serves as a basic introduction to some of the major overarching theories and the research history.

OVERVIEW OF STUDIES

This visual attention task has not previously been studied within the realm of shared attention research. A prior study in our laboratory began to examine this question, but it was ambiguous with regards to the goal structure relevant with the present co-attendees. The current study utilizes a cooperative or competitive goal structure within shared and non-shared attention settings to assess performance on a MOT paradigm. To answer our research questions, we originally created and distinguished between five conditions in which participants were randomly assigned: synchronous cooperation, asynchronous cooperation, synchronous competition, asynchronous competition, and solo competition.

Chapter 2. Method

PARTICIPANTS

One hundred and fifty-two undergraduate students from the University of Tennessee, Knoxville participated in this experiment in exchange for half an hour of research course credit. This sample included 70.4% female participants, with an average age of 18.80 (SD=2.67). Participants reported ethnicity as Caucasian (80.9%), African American or Black (5.3%), Asian or Pacific Islander (4.6%), Latino or Hispanic (3.3%), "other" (2.0%), and American Indian or Alaskan Native (0.7%). 2.6% choose not to answer the ethnicity question.

MATERIALS AND PROCEDURE

Upon arrival to the laboratory, participants were invited into the lab, read, signed, and were offered a copy of the informed consent. After giving consent, participants across all conditions engaged in an Alternative Uses Task sitting at a small table next to one another (Guilford, 1967; Silvia et al., 2008; See Appendix C). This is a creativity task in which participants come up with as many creative uses for a brick as possible together in three minutes. For the synchronous condition, this serves to unite the participants and make them feel relationally close to their partner, creating a potential state of shared attention. However, the creativity task was completed across all conditions in order to maintain consistency within the procedure. All participants received positive feedback on their completion of the task.

Following the creativity task, participants were each seated in their own cubicle. All participants were shown an example video of the MOT paradigm in order to have an adequate understanding of the task they were about to perform, and they were asked if they had any questions in regard to the task. Across all conditions, each participant partook in two blocks of 12 trials each, totaling 24 trials. The dots moved at a fixed speed of 10 degrees/ second, as was

determined to be the most manageable in a pre-testing study. However, there was ranging difficulty in the MOT; all trials had 10 targets, but participants were sometimes asked to track three, sometimes four, and sometimes five dots. This difficulty was balanced with eight trials of three, eight trials of four, and eight trials of five dots for all participants (see table 1). The trials were presented in a fixed order with equal yes and no probes (see table 2). The participants viewed the MOT paradigm on a large 65" television screen approximately six feet away from the participants.

In this MOT task, as each trial began, the screen prompted participants to follow the dots that were shown with a white highlight around them. The highlight then fades, and all of the dots begin to move. Upon completion of the dot movement, one dot is highlighted again, and a question appears on the screen: Was this dot one of the originally highlighted ones? Y/N. Participants clicked Y on the keyboard if the answer was yes and N on the keyboard if the answer was no.

As previously mentioned, this study included five conditions. In the synchronous conditions, participants were in shared attention settings, in which they attended to the MOT paradigm at the same time as their partner in the study. By contrast, in the asynchronous conditions, while one person was completing the MOT paradigm, the other person was working on a distractor task, a word search. Within the cooperation conditions, participants were told, "You will be working as a team, and your scores will be summed and compared to other teams participating in the study. Each member of the highest scoring team will receive a $50 Amazon gift card upon the study's completion." In the competition conditions, participants were told "You will be working as an individual, and your score will be compared to other individuals competing in this study. The individual with the highest score will receive a $50 Amazon gift

card upon the study's completion." All of the solo condition participants were given the competition statement, as there was no other person in the room that could be considered a member of their team. These statements were presented after the MOT example video but before the first block began.

Generally, participants across all conditions completed the two blocks as well as two equally timed sessions with the word search distraction task. In the synchronous conditions, both participants completed the first MOT block, followed by the word search distraction, then the second MOT block, followed by another round of the word search distraction. This served to maintain consistency in the timing and completion of tasks. By contrast, in the asynchronous conditions, while one participant completed the first MOT block, the other worked on the word search distraction, and they switched back and forth until they had each completed the two MOT blocks and worked on the word search distraction two times. In the solo condition, the participants also completed the two MOT blocks as well as worked on the word search distraction two times. Having the word search distraction across all participants served to give the participants a break from the tracking in order to be able to rest and refocus. The exact sequence of activities across synchronous and asynchronous conditions can be seen in table 3.

Following the major bulk of the experiment, all participants filled out a survey in which they answered questions and completed scales relevant to the study. The first completed scale was the Positive and Negative Affect Scale, a self-report questionnaire to measure affect (PANAS; Watson et al., 1988; see appendix D). Respondents indicated to what extent they felt different feelings and emotions during the dot tracking task on a 5-point Likert-style scale from 1 (not at all) to 5 (extremely). Example items include, "Interested" (positive affect) and "Upset"

(negative affect). Separate positive affect and negative affect were calculated, which included 10 items each.

Next, participants answered another set of questions also on a 5-point Likert-style scale from 1 (not at all) to 5 (extremely). This set of questions targeted the physical and mental fatigue of the participants, as well as items that assessed motivation, enjoyment, feelings about their performance, and feelings of competition regarding the dot tracking task (see appendix E).

Participants then completed the Competitiveness Questionnaire, a self-report trait competitiveness scale (Griffin-Pierson, 1990; see appendix F). On a 5-point Likert-style scale from 1 (strongly disagree) to 5 (strongly agree), participants indicated how well the sentences described their feelings in general. This scale was constructed to measure two aspects of competitiveness: interpersonal competitiveness and goal competitiveness (Griffin-Pierson, 1990). Example items include, "I would want to get an A because that is the best grade a person can get" (goal competitiveness) and "I perform better when I am competing against someone rather than when I am the only one striving for a goal" (interpersonal competitiveness).

Finally, participants were asked how frequently they engage in activities that may influence their performance on the MOT paradigm. Respondents answered questions on a 5-point Likert-style scale from 1 (never) to 5 (very frequently). The questions involved how frequently participants play videogames by themselves or with others that utilize hand-eye coordination, how often they participate in sports that require hand-eye coordination, and how often they drive a vehicle. This page also included demographic information including sex, age, and ethnicity (see appendix G).

The above-mentioned portions of the survey were uniform across all conditions. For the conditions that involved two people, there was an additional page to the survey that assessed

feelings towards the other person participating in the study during the experimental session. Said differently, the synchronous and asynchronous cooperation and competition conditions had an extra portion of the survey regarding their partner (i.e. everyone except the solo competition condition received the final portion of the survey). Two five-item subscales were completed. This first subscale assessed their enjoyment of their partner and the task with their partner, and it was a 7-point Likert-style scale from 1 (not at all) to 7 (very much) (Haj-Mohamadi, Fles, & Shteynberg, 2018). Sample items include "How much did you enjoy working with your partner?" and "How much would you like to complete this task again with your partner in the future?" The second subscale was also a five item 7-point Likert-style scale from 1 (not at all) to 7 (very much) that asked questions about their partner in the study (Haj-Mohamadi, Fles, & Shteynberg, 2018). This subscale served to provide a measure of affiliation and closeness in the study. Sample items include "How psychologically close do you feel with your partner?" and "How comfortable do you feel with your partner?" There was a final single item on the partner question page that inquired about whether the participant already knew the other participant. It was a 5-point Likert-style scale from 1 (not at all) to 5 (very well), as knowing the participant beforehand could influence their feelings toward their partner (see appendix H).

After completing the entirety of the study, participants were debriefed and asked if they had questions or concerns regarding the study. After adequately answering questions, they were thanked and dismissed.

Chapter 3. Results

Due to an unforeseen issue with random assignment of the alone condition, we only analyzed the conditions with two participants as a 2x2 between-subjects design. The data from the alone condition (n=52) was not truly randomly assigned because participants in this condition either were alone because their partner did not show up for their time slot when they were assigned to a partner condition, or because they signed up at odd times when other participants were not signing up. When excluding the alone condition, we were left with 100 participants in the 2x2 between-subjects design.

PERFORMANCE RESULTS

OVERALL PERFORMANCE

Participants' performance scores were calculated by dividing the number of correct responses by 24, as there were 24 total trials. The number of participants, means, and standard deviations for each cell of the experimental design are provided in table 4. A two-way ANOVA was conducted to examine the effect of goal type (e.g. cooperation or competition) and shared attention (e.g. synchronous or asynchronous) on performance. The main effect of cooperation/competition was not significant, $F(1,96) = 0.38$, $p = 0.54$. The main effect of shared attention was marginally significant, $F(1,96) = 3.28$, $p = 0.07$, such that those in the asynchronous conditions ($M = 0.78$, $SD = 0.08$) had marginally stronger performance than those in the synchronous conditions ($M = 0.74$, $SD = 0.12$). Finally, there was not a statistically significant interaction between shared attention and goal type on performance, $F(1,96) = 0.076$, $p = 0.78$. Based on these general performance findings, it appears that the two independent variables, cooperation/competition and shared attention, did not influence MOT tracking performance in this experiment.

PERFORMANCE BY BLOCK

Next, we also explored performance separately in Block A and Block B, with performance scores being calculated by dividing the number of correct answers by 12, as there were 12 trials within each block. Descriptive statistics by cell are provided in table 5. Similar to overall performance, a two-way ANOVA was conducted to examine the effect of cooperation/ competition and shared attention on Block A performance. For Block A, there was no main effect of cooperation/ competition, $F(1,96) = 0.38$, $p = 0.54$, no main effect of shared attention, $F(1,96) = 0.54$, $p = 0.47$, and no statistically significant interaction between goal type and shared attention on performance, $F(1,96) = 0.41$, $p= 0.53$. Here, we see no evidence of the influence of cooperation, competition, or shared attention on Block A performance.

We did the same test for Block B performance. Descriptive statistics by cell are provided in table 6. There was no main effect of cooperation/ competition, $F(1,96) = 0.09$, $p = 0.77$. There was a main effect of shared attention, $F(1,96) = 3.89$, $p = 0.05$, such that asynchronous participants performed better in Block B ($M = 0.80$, $SD = 0.10$) than did synchronous participants ($M= 0.75$, $SD= 0.16$). There was also no statistically significant interaction between shared attention and goal type on Block B performance, $F(1,96) = 1.14$, $p = 0.29$.

BLOCK B TRIAL DIFFICULTY

As stated before, the trials have differing levels of difficulty, with trials varying such that participants were asked to track either three, four, or five dots. In order to further explore what was happening in the Block B performance for the asynchronous conditions, a within-subjects contrast in repeated measures ANOVA was conducted and revealed a significant three-way interaction between difficulty (3, 4, or 5 dots to track), shared attention (synchronous or asynchronous) and goal type (cooperation or competition), $F(1,96) = 4.85$, $p = 0.03$. Because this

was not something that we made a priori predictions, we did not choose to decompose the interaction, but Figures 4 and 5 show the general trends that were found, and table 7 provides the descriptive statistics. Broadly speaking, with increased difficulty, asynchronous participants do better when competing, but synchronous participants do better when cooperating in this study.

SUBJECTIVE EXPERIENCE RESULTS

While I only made specific hypotheses about goal type (cooperation/competition) and shared attention's (synchronous/ asynchronous) effect on performance, a few results were of interest in terms of the participants' experiences during the experiment.

MOTIVATION

The survey had a one-item measure that asked participants "How motivated were you to perform well?" It was answered on a 5-point Likert scale from 1 being "not at all" to 5 being "extremely." Based on this question, a two-way ANOVA was conducted to understand how shared attention and cooperation/competition influence feelings of motivation. There was no main effect of cooperation/competition, $F(1,96) = 0.45$, $p = 0.51$, and no statistically significant interaction between the two independent variables, $F(1,96) = 0.32$, $p = 0.58$. There was a main effect of synchrony, $F(1,96) = 9.91$, $p = 0.002$, such that those in the synchronous conditions ($M = 4.19$, $SD = 0.66$) reported feeling significantly more motivated to perform well than those in the asynchronous conditions ($M = 3.63$, $SD = 1.02$). This finding suggests that although there was no observed effect on performance, those who performed the task at the same time were more motivated to do well than the participants doing the task separately.

CLOSENESS

The final survey also included a five-item scale of questions relating to closeness and affiliation that was mentioned in the methods section. We averaged the scores of these five items

($\alpha = 0.93$) for each participant to create a single score. Correlation coefficients among each closeness item as well as the single score can be found in table 8. Then, a two-way ANOVA was conducted to see if shared attention and cooperation/competition influence feelings of closeness. There was no main effect of shared attention, $F(1,94) = 1.20$, $p = 0.28$, and no main effect cooperation/competition, $F(1,94) = 0.18$, $p = 0.68$. There was a statistically significant interaction between goal type and shared attention, $F(1,94) = 4.72$, $p = 0.03$. As seen in figure 6, simple main effects analysis showed that within competition, synchronous participants ($M = 3.44$) reported more feelings of closeness than asynchronous participants ($M = 2.55$), $F(1,94) = 5.20$, $p = 0.03$. This was not the case within cooperation, $F(1,94) = 0.60$, $p = 0.44$. These findings suggest that within competition, the effects of shared attention do influence closeness, but when cooperating, the effects of shared attention do not matter as much. Simple effects analysis also suggested that in synchrony, competing participants ($M = 3.44$) do marginally better than cooperating participants ($M = 2.73$), $F(1,94) = 3.60$, $p = 0.06$, but this is not the case within asynchrony, $F(1,94) = 1.50$, $p = 0.23$.This suggests that when sharing attention, competing individuals do marginally better than cooperating individuals, but this is not the case when there is no shared attention.

However, an important caveat exists about the relational closeness data. Although there was a statistically significant interaction between the independent variables when including all cases, I thought it might be important to exclude participants who already knew each other prior to the start of the study, as these individuals would already potentially have closeness feelings that were not a result of the experimental design. When excluding participants who said anything other than “not at all” to answer the question “how well do you know the other participant?,” there is no main effect of shared attention $F(1,82) = 1.56$, $p = 0.22$, no main effect of goal type,

$F(1,82) = 0.08$, $p = 0.77$, and the interaction between the variables no longer holds, $F(1,82) = 0.79$, $p = 0.38$. As a result, with people who do not know each other prior to the study, shared attention and cooperation/competition did not seem to influence self-reported feelings of closeness. However, this severely limits the sample size within each cell.

COMPETITION

The survey also contained a one-item measure asking participants, "Did you feel at all competitive?" that was answered on a 5-point Likert scale from 1 being "not at all" to 5 being "extremely." A two-way ANOVA was conducted to understand how shared attention and cooperation/competition influenced feelings of competitiveness. Descriptive statistics can be found in table 9. There was no main effect of shared attention, $F(1,96) = 0.14$, $p = 0.71$. Interestingly, there was also no main effect of cooperation/ competition, $F(1,96) = 1.15$, $p = 0.27$. Finally, there was no interaction between shared attention and cooperation/ competition, $F(1,96) = 0.27$, $p = 0.60$. Based on these findings, it seems that the cooperation and competition manipulation potentially did not work, as the whole sample was feeling moderately competitive, when we would have expected the competition conditions to feel more competitive than the cooperative ones.

Chapter 4. General Discussion and Limitations

DISCUSSION

The purpose of this study was to understand how a cooperative or a competitive mindset might influence the effect of shared attention on MOT performance. Four experimental groups were analyzed: synchronous cooperation, synchronous competition, asynchronous cooperation, and asynchronous competition. My main shared attention hypothesis was that cooperation will moderate the effect of shared attention on performance, such that during synchronous co-attention, a cooperative scenario will improve shared attention's influence on performance. Evidence from this study does not provide evidence that this is the case. There were no significant differences between groups in overall performance. There was a marginally significant main effect of shared attention, with the asynchronous conditions performing marginally better than the synchronous conditions. This finding is the opposite of the prediction of shared attention theory. Further, there were no differences between groups in Block A performance; shared attention and goal type did not influence Block A performance in this study. In Block B performance, there was a main effect of shared attention, but again, in the opposite direction than was predicted by shared attention theory; asynchronous conditions performed better than the synchronous conditions in Block B. A potential explanation for this result may be due to an unintended feature of the experimental design. Because participants in the asynchronous conditions were performing different tasks at different times, there was the possibility that asynchronous participants were able to "cheat" by watching the other person perform the MOT task while they were supposed to be working on the word search. This could have allowed participants to gain more exposure to the task and potentially learn and improve

their performance. In the synchronous conditions, the blocks of the MOT task were completed at the same time, so there was no time for possible extra learning or exposure to the task.

In terms of the Block B trial difficulty findings, the preliminary general trend seems to be that asynchronous participants tend to do better when competing, while synchronous participants tend to do better when cooperating. Thinking about it differently, asynchronous participants tend to do worse when cooperating while synchronous participants tend to do worse when competing. This suggests that in some way, asynchronicity and competition may potentially fit together better while synchronicity and cooperation may potentially fit together better.

Overall, performance did not seem to be strongly influenced by this experimental design. Perhaps because the MOT task has a lot of concurrently presented stimuli, participants may not feel like they are attending to the same thing at the same time because of the sheer number of simultaneously moving stimuli, thus impairing the shared attention state and hence eliminating cognitive prioritization. Therefore, a different performance task with a similar experimental set-up may elicit a stronger shared attention state. Said differently, a task with more specificity and focus may have better served to create a state of shared attention where cognitive prioritization occurs to promote social coordination.

In terms of the subjective experience results, as is found in the shared attention literature, this study did find evidence that synchronous individuals were more motivated to perform better than asynchronous individuals, even though this higher motivation was not reflected in actual performance. This finding coincides with previous shared attention research, suggesting that the shared attention state leads to stronger motivation (Shteynberg & Galinsky, 2011). Why did this motivation not result in stronger performance? One possible explanation for this is that

participants are already at their cognitive capacity when tracking the dots, and even though they wanted and intended to do better, there was not much room for improvement.

Further, the results of this study found that within competition, synchronous participants reported more feelings of closeness than asynchronous participants when all participants were included. This suggests that, shared attention matters more for competition but not for cooperation. This is also inconsistent with what shared attention theory predicts, and it is difficult to know what was occurring. However, this has finding has been replicated in another similar MOT study in the lab. Previous research has also found evidence of synchronous co-attention and joint eye-gaze leading to greater feelings of affiliation, although it has not been looked at from a cooperative/competitive context (Haj-Mohamadi et al., 2017; Wolf et al., 2016). One potential explanation is that something about synchronous competition makes the participants imagine the mind of the other person more, which leads to increased feelings of closeness. However, when excluding participants that already knew each other prior to the study, the interaction was no longer statistically significant; on the other hand, making these exclusions also severely limits the sample size. Having more participants with larger cell sample sizes to collect more data would provide a clearer picture as to what is truly taking place.

Finally, feelings of competitiveness did not differ between cooperative and competitive conditions. This indicates that the manipulation of summing or comparing participant scores may not have adequately elicited different states. All conditions seemed to feel moderately competitive. Perhaps because the performance task could be more integrative in order to more distinctly differentiate competition from cooperation.

LIMITATIONS

As with all studies, this study has a number of limitations that could be improved in the future to better answer the research question. This thesis study served as a first attempt at understanding how shared attention would function in externally identified cooperative and competitive settings. However, there is clearly room for improvement and things that could be done differently in the future. First, as previously mentioned, a different performance task that has a clearer single stimulus for synchronous participants to simultaneously co-attend to could be utilized to see if there are also null effects in other, possibly more simple domains. Perhaps utilizing a task that already has been used in previous shared attention studies would serve as a more effective dependent variable. Further, this would likely more effectively enhance the shared attention state and create a stronger shared attention manipulation for participants to experience.

Second, a better cooperation and competition manipulation could be used, as telling the participants their scores will either be compared or summed, to compete or cooperate with their partner respectively, may be more mathematically cooperative or competitive rather than experientially cooperative or competitive. Perhaps allowing participants to more clearly feel competitive by seeing their scores as compared to the other participant or by working together in a collaborative environment to feel cooperative would better induce feelings of competition or cooperation.

Third, a randomly assigned alone condition as well as possibly adding two more conditions where cooperation and competition are not specified could also provide useful comparison groups in order to understand what is taking place. Conditions that have two participants without mention of a goal would provide more value in terms of understanding current shared attention research as compared to shared attention in these contexts. Further,

comparisons could be made with regards to both cooperation enhancing shared attention and competition diminishing shared attention when adding these two conditions.

Fourth, if time allowed, a larger sample size would be helpful in order to increase the power of the statistical analyses. Due to the lower than expected number of participants signing up in conjunction with the time frame to collect data, there were only between 20 to 30 participants in each cell of the design. This could be a limiting factor to fully understanding the effects of the manipulation in this study.

Overall, a conceptual replication of this study with a larger sample size could provide further insight into this research question. Intuitively, it seems that cooperative and competitive settings could have an influence on shared attention, so further study in this area may prove fruitful.

Chapter 5. Conclusion

Shared attention, or synchronous co-attention to a stimulus with a similar other, leads to cognitive prioritization that is consequential in many psychological domains (e.g. memory, motivation, emotional experience), with the ultimate function of shared attention being to generate collective knowledge (Shteynberg, 2015). In a cooperative setting, participants' goals are linked in such a way that if one person succeeds, the other also succeeds; in a competitive setting, participants' goals are linked in such a way that if one participant succeeds, the other fails (Deutsch, 1949).

I intended to create cooperative and competitive settings in a laboratory environment to explore these face-to-face experiences between similar or affiliated participants. Participants were made to feel cooperative or competitive with their partner based on how the scores were tallied during a MOT task where we measured performance. We did not find support for the shared attention hypothesis that during synchronous co-attention, a cooperative setting will increase shared attention's influence on performance. We also did not find evidence supporting the alternative hypothesis that due to social comparison, a competitive setting will increase shared attention's influence on performance. In all, there were not major differences between groups in terms of overall performance.

This study serves as an important starting point for understanding shared attention with regards to how the co-attending other is being perceived by a participant. If the similar other is viewed as a cooperator or as a competitor, differing psychological mechanisms could be in use. Cooperative and competitive scenarios while sharing attention likely take place in the real-world; for example, playing on a team with or against a friend in a videogame or collaborating on a project within a workplace environment could elicit these types of scenarios. Gaining a fuller

understanding of the impact of these variables, perhaps with a similar conceptual replication but different experimental set-up, could prove useful for the contribution to the shared attention literature.

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Appendices

Appendix A: Tables

Table 1.

Number of Dots to Track by Trial

Trial #	1	2	3	4	5	6	7	8	9	10	11	12
Block												
A	4	3	5	4	3	4	5	3	4	5	5	3
B	3	5	3	4	5	3	5	4	4	3	5	4

Table 2.

Probe Answers by Trial

Trial #	1	2	3	4	5	6	7	8	9	10	11	12
Block												
A	Y	Y	N	Y	N	N	Y	N	N	Y	N	Y
B	Y	N	Y	Y	Y	N	Y	N	N	N	N	Y

Note. Y = Yes; N = No

Table 3.

E*xact Sequence of Activities During Synchronous Versus Asynchronous Conditions*

Synchronous Conditions	**Asynchronous Conditions**
P1 and P2: Brick Task	P1 and P2: Brick Task
P1 and P2: Block A MOT Task	P1: Block A MOT Task P2: Word Search
P1 and P2: Word Search	P1: Word Search P2: Block A MOT Task
P1 and P2: Block B MOT Task	P1: Block B MOT Task P2: Word Search
P1 and P2: Word Search	P1: Word Search P2: Block B MOT Task
P1 and P2: Survey	P1 and P2: Survey

Note. P1= Participant 1; P2= Participant 2

Table 4.

Descriptive Statistics for Overall Performance by Condition

Condition	n	M	SD
Asynchronous Competition	20	.79	.08
Asynchronous Cooperation	28	.77	.08
Synchronous Competition	30	.74	.12
Synchronous Cooperation	22	.74	.12

Table 5.

Descriptive Statistics for Block A Performance by Condition

Condition	n	M	SD
Asynchronous Competition	20	.76	.14
Asynchronous Cooperation	28	.76	.12
Synchronous Competition	30	.75	.15
Synchronous Cooperation	22	.72	.15

Table 6.

Descriptive Statistics for Block B Performance by Condition

Condition	n	M	SD
Asynchronous Competition	20	.82	.10
Asynchronous Cooperation	28	.78	.10
Synchronous Competition	30	.73	.16
Synchronous Cooperation	22	.76	.17

Table 7.

Descriptive Statistics of Three-Way Interaction in Block B

# of Dots to Track	Shared Attention	Goal	M	SD
3	Asynchronous	Competition	.84	.16
3	Asynchronous	Cooperation	.88	.14
3	Synchronous	Competition	.86	.18
3	Synchronous	Cooperation	.78	.21
4	Asynchronous	Competition	.79	.19
4	Asynchronous	Cooperation	.73	.19
4	Synchronous	Competition	.70	.28
4	Synchronous	Cooperation	.82	.19
5	Asynchronous	Competition	.84	.19
5	Asynchronous	Cooperation	.74	.19
5	Synchronous	Competition	.65	.25
5	Synchronous	Cooperation	.67	.31

Table 8.

Correlations between Closeness Items for All Participants

Closeness Item	1	2	3	4	5	Total Closeness
1	-	.862**	.760**	.794**	.564**	.899**
2	.862**	-	.858**	.857**	.553**	.938**
3	.760**	.858**	-	.846**	.590**	.925**
4	.794**	.857**	.846**	-	.567**	.921**
5	.564**	.553**	.590**	.567**	-	.730**
Total Closeness	.899**	.938**	.925**	.921**	.730**	-

Note. **Correlation is significant at the 0.01 level

Table 9.

Descriptive Statistics for Competition Item

Condition	n	M	SD
Asynchronous Competition	20	3.50	1.40
Asynchronous Cooperation	28	3.36	1.10
Synchronous Competition	30	3.73	1.20
Synchronous Cooperation	22	3.32	1.49

Appendix B: Figures

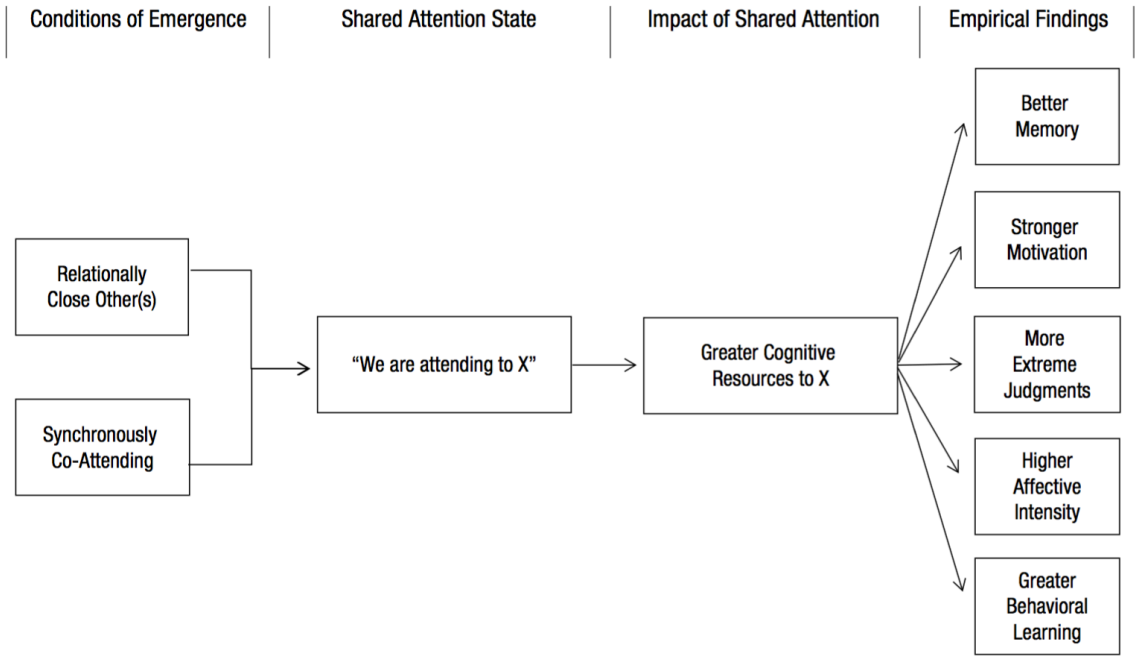

Figure 1. Shared Attention Research

Note. Reprinted from "Shared Attention", by Shteynberg, G., 2015, *Perspectives of Psychological Science,10*(5), 579-590.

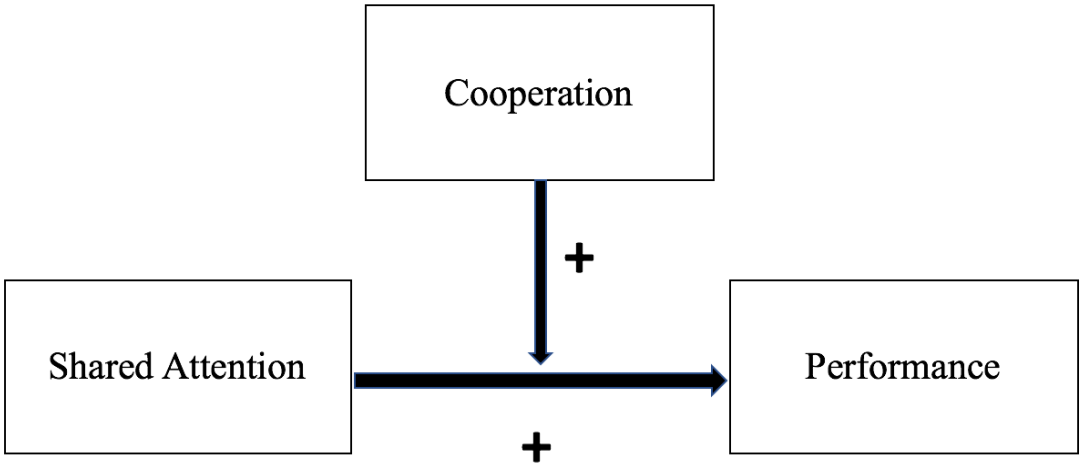

Figure 2. Shared Attention Hypothesis

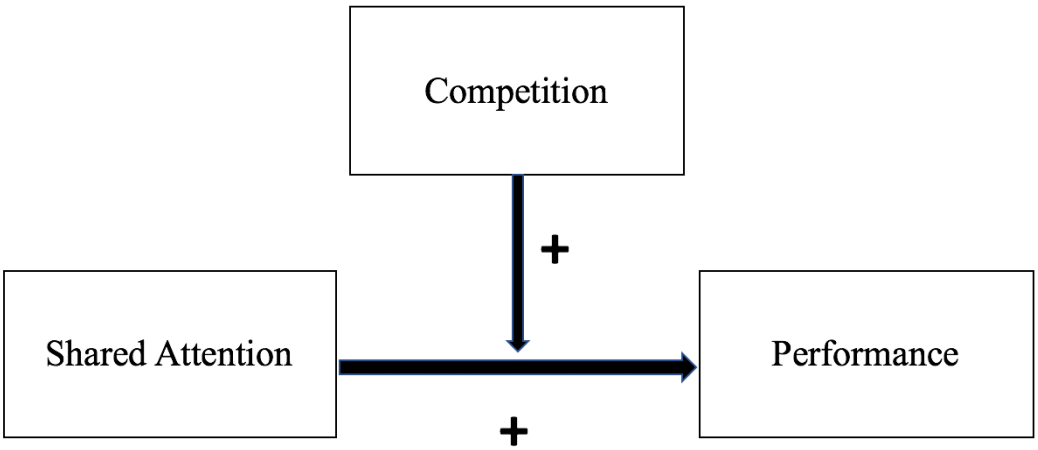

Figure 3. Alternative Hypothesis

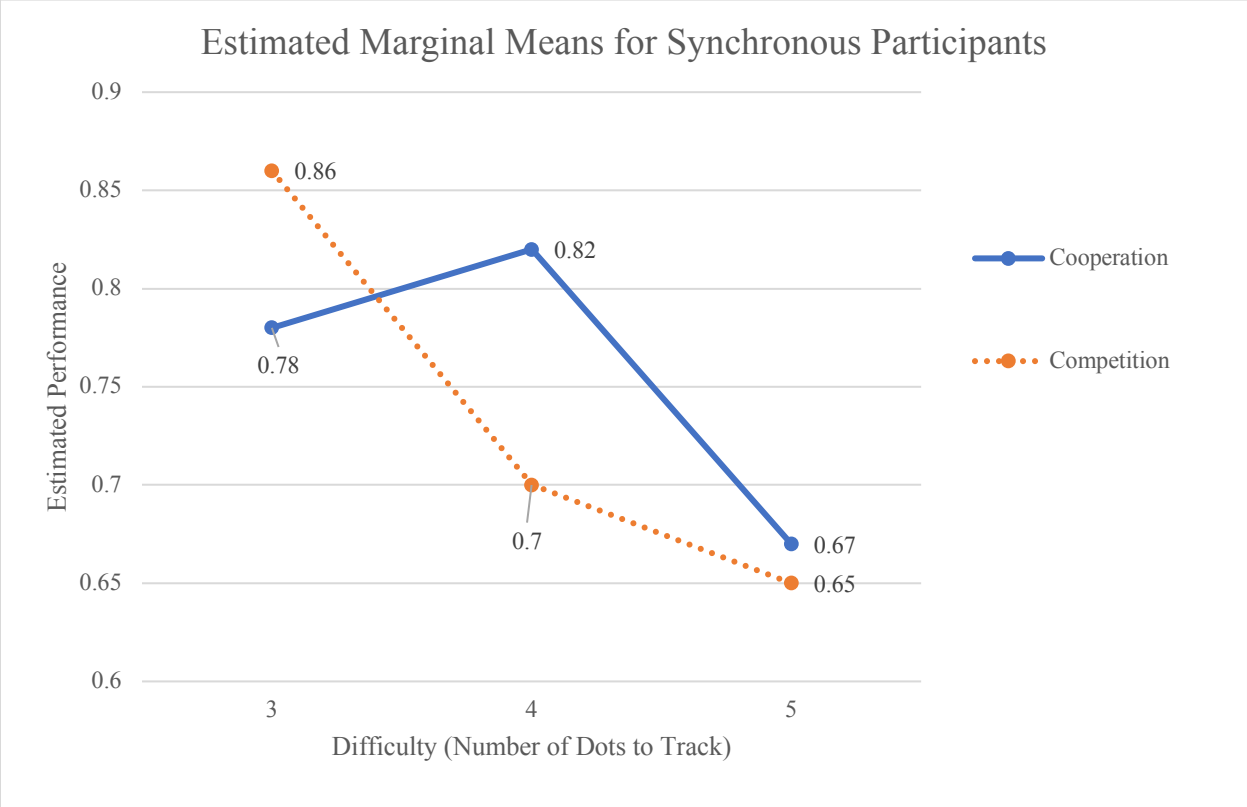

Figure 4. Difficulty * Shared Attention * Goal Type Interaction for Synchronous Participants

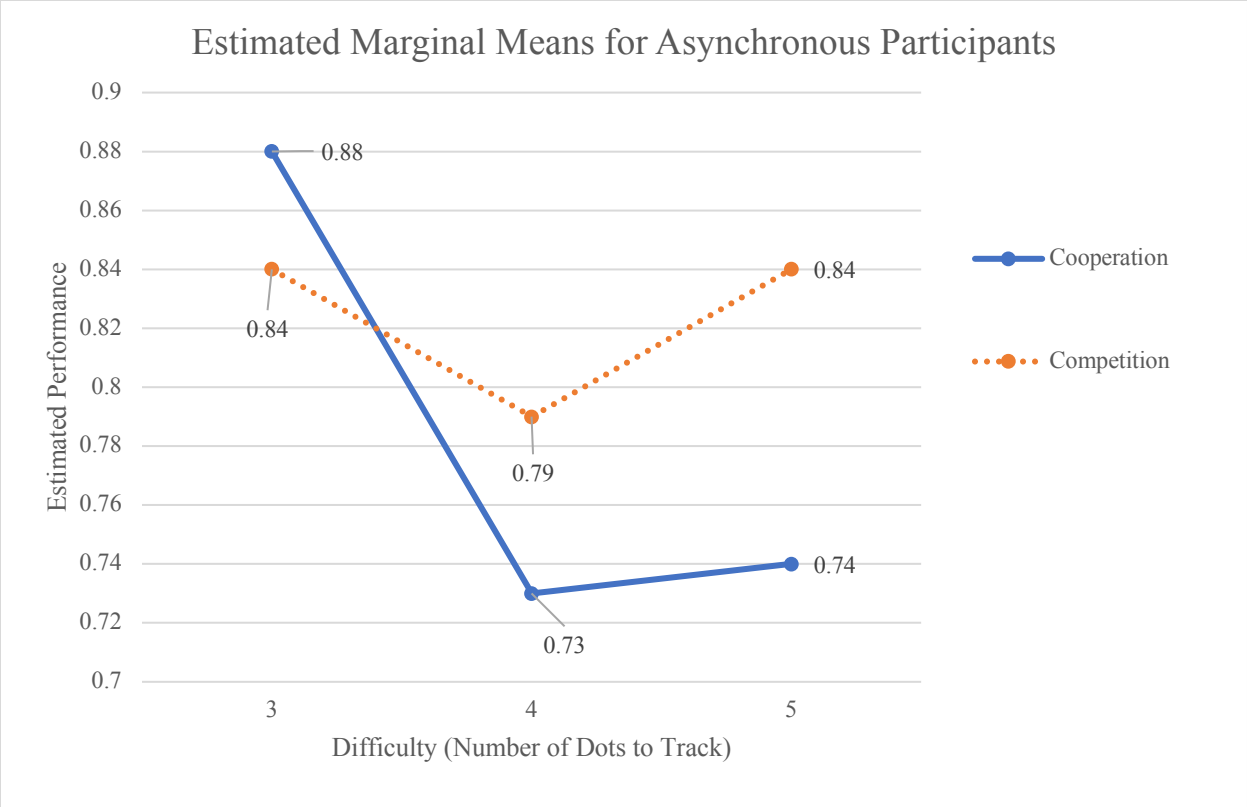

Figure 5. Difficulty * Shared Attention * Goal Type Interaction for Asynchronous Participants

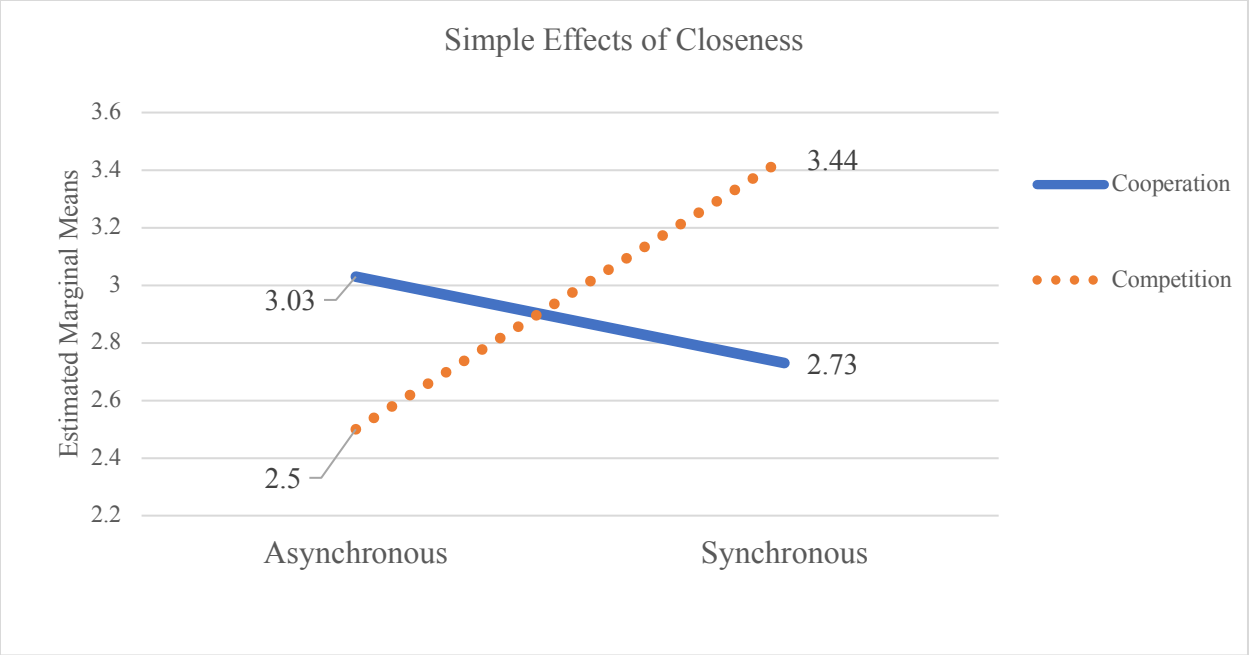

Figure 6. Simple Effects Analysis of Closeness

Appendix C: Creativity Task (Guilford, 1967; Silvia et al., 2008)

For this task, you should write down all of the original and creative uses for a brick that you can think of. Certainly there are common, unoriginal ways to use a brick; for this task, write down all of the unusual, creative, and uncommon uses you can think of. You'll have three minutes. Any questions?

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____

Appendix D: PANAS (Watson et al., 1988)

Indicate to what extent you felt this way <u>during the dot tracking task</u>

1	2	3	4	5
Not at All	A Little	Moderately	Quite a Bit	Extremely

_____1. Interested

_____ 2. Distressed

_____ 3. Excited

_____ 4. Upset

_____ 5. Strong

_____ 6. Guilty

_____ 7. Scared

_____ 8. Hostile

_____ 9. Enthusiastic

_____ 10. Proud

_____ 11. Irritable

_____ 12. Alert

_____ 13. Ashamed

_____ 14. Inspired

_____ 15. Nervous

_____ 16. Determined

_____ 17. Attentive

_____ 18. Jittery

_____ 19. Active

_____ 20. Afraid

Appendix E: Questions Regarding MOT paradigm

1	2	3	4	5
Not at All	A Little	Moderately	Quite a Bit	Extremely

Indicate to what extent you feel this way.

_____ 21. How mentally fatigued do you feel?

_____ 22. How physically fatigued do you feel?

Indicate to what extent you felt this way <u>about the dot tracking task</u>

_____ 23. How motivated were you to perform well?

_____ 24. How much did you enjoy this task?

_____ 25. How much did you like your performance?

_____ 26. Did you feel at all competitive?

Appendix F: Competitiveness Questionnaire (Griffin-Pierson, 1990)

1	2	3	4	5
Strongly Disagree				Strongly Agree

_____1. I would want to get an A because that is the best grade a person can get.

_____2. I perform better when I am competing against someone rather than when I am the only one striving for a goal.

_____3. I do not care to be the best that I can be.

_____4. When applying for an award I focus on my qualifications for the award and why I deserve it, not on how the other applicants compare to me.

_____5. I do not feel that winning is important in both work and games.

_____6. When I win an award or game it means that I am the best compared to everyone else that was playing. It is only fair that the best person wins the game.

_____7. In school, I always liked to be the first one finished with a test.

_____8. I am not disappointed if I do not reach a goal that I have set for myself.

_____9. I have always wanted to be better than others.

_____10. Achieving excellence is not important to me.

_____11. When nominated for an award, I focus on how much better or worse the other candidates' qualifications are as compared to mine.

_____12. I would want an A because that means that I did better than other people.

_____13. I wish to excel in all that I do.

_____14. Because it is important that a winner is decided, I do not like to leave a game unfinished.

_____15. I would rather work in an area in which I can excel, even if there are other areas that would be easier or would pay more money.

Indicate how well the following sentences describe your feelings <u>in general.</u>

Appendix G: Frequency of Hand-Eye Coordination Activities and Demographic Information

1	2	3	4	5
Never	Rarely	Occasionally	Frequently	Very Frequently

_____ 1. How often do you play videogames by yourself that require hand-eye coordination?

_____ 2. How often do you play videogames with others that require hand-eye coordination?

_____ 3. How often do you participate in sports (organized or recreational) that require hand-eye coordination?

_____ 4. How often do you drive a vehicle?

Sex:

Male O Female O

Age: _____ years

Ethnicity:

O African American/Black

O Asian or Pacific Islander

O Caucasian

O Latino or Hispanic

O American Indian or Alaskan Native

O Other

Appendix H: Affiliative Partner Items (Haj- Mohamadi, Fles, & Shteynberg, 2018)

1	2	3	4	5	6	7
Not at All			Neutral			Very Much

Please use the following scale to answer the questions below.

_____ 1. How much did you enjoy this task?
_____2. How much did you like your performance?
_____3. How much did you like your partner?
_____4. How much did you enjoy working with your partner?
_____5. How much would you like to complete this task again with your partner in the future?

1	2	3	4	5	6	7
Not at All			Neutral			Very Much

Please answer the following questions <u>about your partner in this study</u> using the scale below.

_____ 1. How psychologically close do you feel with your partner?
_____ 2. How interpersonally close do you feel with your partner?
_____ 3. How socially close do you feel with your partner?
_____ 4. How connected do you feel with your partner?
_____ 5. How comfortable do you feel with your partner?

How well do you know the other participant?

1	2	3	4	5
Not at All	A little	Acquaintances	Quite a Bit	Very Well

Vita

Sydney Blaine Michelson was born in Knoxville, Tennessee. She graduated from Webb School of Knoxville in 2011. She went on to the University of Tennessee, Knoxville, where she completed her Bachelor's of Arts degree in psychology with a minor in child and family studies in 2015. She continued at the University of Tennessee, Knoxville to pursue her Master's of Arts degree in experimental psychology with a focus on social psychology research.