Neural Response to Self-Control Exertion in Competitive Personality Traits

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ABSTRACT

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Self-control is an individual's ability to direct attention and action towards a specific goal while inhibiting other actions or impulses (Baumeister et al., 2007). Through the use of EEG the question of whether self-control is promoted by a more competitive personality can be addressed. In previous research the event related potential called the error related negativity (ERN) has been shown to appear in a greater magnitude in individuals performing a task that requires cognitive control, like a self-control task, when they make a mistake (Hajack et al. 2005). This is thought to occur because the amplitude of the ERN is associated with an individual's response conflict when an error has been made. This study uses the ERN as a physiological indicator of task engagement and motivation, to investigate how neural responses to self-control failure can be mediated by competitive personality traits. Through the use of the Go/No-Go self-control task, both individually and jointly, it is possible to measure the ERN in response to self-control exertion. The task was explained to the participants as a game with three rounds and the option to earn points to win. This study originally hypothesized that a more competitive person would express a stronger ERN while performing a self-control task because of their drive to succeed over the other participant. In addition it was hypothesized that competitiveness would enhance accuracy of task performance due to an increased motivation and focus. However, we found that competitive individuals gain no advantage of performance on the task.

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INTRODUCTION

In the modern world all fields of work from corporate to academic settings demand teamwork of employees. This requirement of teamwork is promoted or damaged by a combination of an individual's traits and the abilities of those with whom they interact. Personality traits such as competitiveness or cooperativeness can play a major role in how well individuals participate in teamwork in different conditions. This study aims to examine the effect of competitive personality traits on task performance and the neural response of self-control exertion, all while in the presence of others versus alone. Previous research has shown that self-control is a key element in promoting success in an individual's personal life as well as professional one (Baumeister et al., 2007). A look at how competitive personality traits lend themselves towards helping or hindering an individual's exertion of self-control is an area of needed research. Until this point research has primarily focused on the traits separate from the possible effects they could have on performance of self-control exertion (Ogilvie, 1968; Bogoyavlenskaya & Klyueva, 2013; Chamorro-Premuzic & Furnham, 2003). Specifically it is possible that competitive traits and competitive situations serve as a factor in the environment that affects self-control. However, this cross between the factors of personality and performance is lacking in evidence. Competitiveness is typically operationalized as an internal need to succeed either individually or when pitted against another individual in any task (Ogilvie, 1968; Bogoyavlenskaya & Klyueva, 2013; Chamorro-Premuzic & Furnham, 2003). With this in mind we also planned on looking at if the presence of another plays a role in self-control behavior in either a competitive condition or a cooperative one. The idea is that while participating together

with another individual the social aspect of either competition or cooperation will cause an effect when compared to performing alone.

COMPETITIVE PERSONALITY TRAITS

Competition is defined as an internal motivation to succeed in a goal either alone or when performing against another person (Ogilvie, 1996). In the past competitive personality traits have been studied in athletics, high-pressure academic conditions, and corporate conditions (Cole & Quinn, 2011; Wijbenga & Witteloostuijn, 2007). These studies have led to the agreement that those who are highly competitive tend to show more dominant traits overall like ambition (Ogilvie, 1968; Bogoyavlenskaya & Klyueva, 2013; Chamorro-Premuzic & Furnham, 2003). Here we report on a study that investigated how competitive personality traits can enhance task motivation and performance, by looking at the physiological indicators of neural responses to self-control task performance. No previous research has used EEG measures as a physiological indicator of self-control task performance to differentiate competitive individuals from less competitive individuals. Yet, since research has shown that neural responses to errors are detected through EEG it is possible to use these measures to get at physiological signals of task performance (van Schie et al., 2004). Also given that competitiveness leads to higher levels of ambition and motivation to succeed competitive individuals might show a larger neurological response to errors, due to the intrinsic relevance for those individuals. In other words, the high motivation to succeed (Baumeister et al., 2007) could lead to significant differences in the response to errors in competitive compared to non-competitive individuals.

Competition has also been shown to affect different kinds of cognitive task performance. For example different kinds of problem solving are moderated by competitive or cooperative behaviors and conditions (Qin et al., 1995). For example ill-defined problems, those with many

goals, are better solved in an efficient manner by people with more cooperative traits because discussing explanations or answers with others allows for a broader scope of problem solving methods, while well defined problems with a specific goal allow for competitive individuals to focus their strength on that single problem. In this study the Go/No-Go task was well defined and not cognitively taxing allowing for a potential benefit to competitive individuals. With the ability to focus on one goal a competitive individual is able to place all their efforts towards that single goal (Qin et al., 1995). Competition benefits problem solving of tasks with a specific goal or specific strategy that must be used. Cooperation benefits problem solving of tasks with more than one solution or possible strategy (Qin et al., 1995). By providing participants with a specific goal we were able to control for enhancement of cooperative people's problem solving benefits.

Competition can and does take on different forms depending on the kind of competitive behavior being demanded and in what setting it is being exerted (Cole & Quinn, 2011). The condition, or the environment drives the different kinds of competitive behavior. In a modern sense environmental differences have been shown to change the competitive strategies of entrepreneurs (Wijbenga & Witteloostuijn, 2007). The more stable an environment, the more likely a competitive entrepreneur with an internal locus of control, trust in their own ability will undertake innovative strategies (Wijbenga & Witteloostuijn, 2007). This shows that depending on the environmental pressures, the expression of competitive behaviors can vary. This understanding of environmental significance on task exertion for competition lead to the use and creation of three conditions of task performance within this study. We wanted to be able to effect how participants perceived the setting they were entering into. So we had three conditions; the cooperative, competitive, and individual. In each condition they performed the Go/No-Go task

but either in cooperation with another participant, competing against another participant, or simply on their own in a separate room.

SELF-CONTROL

This expression of competitive behavior is thought to be mediated by other behavioral traits, such as self-control. Self-control has been shown in previous research to be supported by two main factors; motivational relevance of required self-regulation, and the overall strength of an individual's capacity for self-control (Muraven & Slessareva, 2002; Baumeister et al., 2007;Baumeister & Vohs, 2007). The Strength Model of self-control compares self-control to a muscle which can either be weak or strong (Baumeister et al., 2007). This model also suggests that self-control can be enhanced with practice and through initial motivational relevance (Baumeister et al., 2007). Motivational relevance is an intrinsic drive to do something, or achieve some goal (Baumeister & Vohs, 2007). As self-control is exerted, motivation moderates exertion and depletion of the resource (Muraven & Slessareva, 2002). There is a gap in the literature looking at how motivation can and does impact self-control initially. Only two studies have been found that looked at motivation of goal oriented tasks and self-control (Boucher & Kofos, 2012; Muraven, Rosman, & Gagne, 2008). In these studies however, motivation was measured through self-report measures. In this study rather than relying on self-report measures, although we have a few, a physiological measure recorded through EEG was used. By measuring the neural response to self-control exertion in the form of an event related potential (ERP) it is possible to get a physiological indicator of self-monitoring during a task. It is assumed that competitive individuals have a higher motivation to achieve goals due to their tendency towards ambition and other predominately driven personalities (Ogilvie, 1968; Bogoyavlenskaya & Klyueva, 2013; Chamorro-Premuzic & Furnham, 2003). Therefore it was hypothesized that more competitive

individuals would monitor their own performance greatly, thus displaying greater neural responses to errors.

NEURAL SIGNALS OF SELF-CONTROL

Through the use of EEG measurements of ERPs in response to task performance it was possible to obtain a physiological measure of task investment and motivation. One component of the ERP is called the error related negativity, or ERN, which occurs following erroneous responses (van Schie et al., 2004). The ERN is generated in the anterior cingulate cortex and peaks at about 150 milliseconds post response (Luck, 2005; Gehring et al., 1993). It is a negative deflection of the ERP, which is recorded at the frontal and central electrode sites. Self-control is not always accurate, and failures or errors do happen, thus causing the neural response of the ERN. The ERN has also been shown as a neural response when self-control and cognitive control are being demanded and individuals make mistakes (Inzlicht & Gutsell, 2007; Hajcak et al., 2005). The ERN appears in higher amplitudes when individuals make errors that have high motivational relevance to them as well (Hirsh & Inzlicht, 2010). It is because of the relevance of the ERN to self-control errors that it is often chosen to examine the responsiveness of individuals to self-control exertion and subsequent failures (Inzlicht & Gutsell, 2007; Riesel et al., 2013; Falkenstein et al., 2000; Gehring et al., 1993). Previous research has either focused primarily on self-control failure individually or competitive behaviors in certain populations, but not at how a competitive personality may mediate neural responses to self-control failure while competing. To fill this gap in the literature this study proposed a competitive condition with two participants performing a self-control task jointly and individually. By having individuals participate in pairs we were able to create a believable competitive environment similar to that encountered in daily life. Competition typically occurs between more than one individual. The presence of another

promotes competition due to monitoring of the other (Kang, Hirsh, & Chasteen, 2009). A more competitive individual has more motivation to succeed and so they will be more likely to monitor the performance of the other to gauge their own performance. This suggests that the presence of another does play a role in the neural response of an individual when performing a task. This effect is often called the social facilitation or mere presence effect and has been shown when people perform as a team rather than on their own (Rajecki et al., 1977). Here we manipulate the presence of another and how participants are interacting with them either competitively, cooperatively, or not at all.

OVERVIEW

Through the use of ERN as a physiological indicator of task engagement and motivation this study aimed to investigate how neural responses to self-control failure can be mediated by competitive personality traits. This study had 3 conditions: an individual, cooperative, and competitive condition. In each condition the self-control task used was the Go/No-Go task. Each condition was explained to the participants as a game with the option to gain points to then earn money.

Hypotheses:

1. Participants will show a significant difference of incorrect responses between the three conditions of competitive, cooperative, and individual.
    a. Participants will show a significant interaction of response accuracy and condition of task participation.
2. Participants will show significant negative correlations between competitive trait measures and incorrect responses per condition.
    a. Participants will show a significant interaction of competitive trait measures and condition of task participation.
3. Participants will show significant positive correlations between competitive traits and magnitude of ERN.

METHOD

STUDY DESIGN

This study is a repeated measures 3 x 2 design with two primary factors of condition performance and response accuracy. Each participant performed in all three conditions while paired with another participant, and each participant was scored based on response accuracy of incorrect or correct key-presses and reaction times of correct key-presses. All participants were randomly ordered in the three conditions of the study so as to prevent fatigue or any priming. All conditions were also counterbalanced between the pairs to control for ordering effects. Participants were asked to come into the lab in pairs and played the "game." Following, they were given three scales to fill out, the Competitive Cooperative Personality Scale (Xie et al., 2006, 2011), Self-Control Scale (Tangney et al., 2004), and the Big Five Inventory (John & Srivastava, 1999).

PARTICIPANTS

A total of 18 students (14 female: 4 male) from the Brandeis University population were recruited for the purpose of this study. They were invited into the lab in pairs making a total of 9 pairs. We had originally proposed a total of 20 pairs of participants, but were unable to collect that number. Proposing a sample size of 40 was quite ambitious to begin with. However, to account for the reduction in sample size due to the pairing of participants for analysis the original sample size was proposed. The inclusionary criteria were that they needed to have regular or corrected vision, be fluent in English, and be at least eighteen years of age. All

data collection and recruitment was in accordance with the Brandeis University Institutional Review Board.

GO/NO-GO TASK

The Go/No-Go task is a simple pass/fail test in which participants are instructed to press a response key for the command "Go" in the correct condition and inhibit pressing the response key in the "No-Go" condition. The task is then scored based on accuracy of action in the "Go" condition and inhibition of action in the "No-Go" condition. In the "Go" condition "W" appears on the screen, and in the "No-Go" condition "M" appears. Each condition had a block of 6 practice trials, half "M" and half "W", before the actual condition began. Once the actual condition began there were four blocks of 50 trials making a total of 200 trials in both the joint and the individual condition. Within each block 25 of the trials were "M" and 25 were "W" counterbalanced throughout for a total of 100 "M" and 100 "W" trials. Each stimulus was on the screen for 100ms with a blank screen between each presentation for 2000 ms or until a response was made. All conditions were counterbalanced throughout the study.

For the purposes of this study a joint Go/No-Go task was also created and then used in the cooperative and competitive conditions. In both joint conditions participants were seated at the same computer station viewing the same screen, and performed the Go/No-Go task together. One participant was instructed that their go stimulus was "W" and their no-go stimulus was "M", while the other participant was instructed that their go stimulus was "M" and their no-go stimulus was "W". In the individual condition the participants performed the same task but were seated at two separate computer screens in two separate rooms.

TASK CONDITIONS

In the individual condition participants were seated at their own computer stations in separate EEG recording rooms. Each participant was instructed to use the keyboard set up at the monitor to perform the task. In testing room one they were instructed to press the left control key, and in testing room two they were instructed to press the right control key. Each button was also labeled with a colored circle to ease key-press accuracy. The key they pressed was kept consistent throughout the study, so that when they transitioned into another condition and had to move into one room they did not have to learn a new key-press just a [1]new stimulus response They were asked to perform the Go/No-Go task as outlined before. Participants were told that in this individual round of the game they would receive 1 point for accuracy and speed. They were instructed to focus on speed and accuracy throughout all conditions in order to promote task concentration.

In the cooperative condition both participants were moved into the first EEG recording room and seated next to each other in front of the computer monitor and keyboard. The participant from room one always remained in room one and the participant in room two always was moved to room one and seated at the right of the screen for the joint tasks. They performed the joint Go/No-Go task together, using the key presses determined by their room assignment. Both participants were instructed again as to which stimulus was their own go-stimulus and which was their no-go stimulus. The participants were also told in this condition that they could receive up to two points per person for participating as a team. Again they were instructed to focus on accuracy and speed of the task to promote concentration.

[1] The potential confound of having to switch stimuli was checked and no significant difference was found between those participants who were given a new stimulus and those who were not in either of the joint task conditions (p=.124, p = .093).

In the competitive condition the joint set up from the cooperative condition was used again. The exception was the point system. In this condition participants were told that although they are again being scored on accuracy and speed, only one of them, the one who performs better, would receive up to 2 points at the end of the condition, while the other will receive nothing. The participants were told that they could earn up to five dollars for their performance in all three rounds of the game before they began the study. This provided an initial added motivation for goal achievement for all participants. After all three conditions were performed participants were each given five dollars and debriefed.

PROCEDURE

EEG RECORDING AND DATA

We recorded EEG throughout all conditions and tasks in order to measure the ERN in response to task performance of the self-control task. EEG was measured using a stretch-lycra electrode cap with 32 active electrodes per participant. Data was recorded using BrainVision recorder software (Brainproducts, Munich, Germany). EEG data was analyzed using BrainVision Analyzer software (Brain Products, Munich, Germany). ERN averages were computed for correct and erroneous trials separately and based on condition. The EEG was corrected for horizontal and vertical eye movements using semi-automatic channel inspection filtered with a 0.01 Hz high-pass filter and a 25 Hz low-pass filter marking segments as bad 100ms before and after the artifact. The baseline was corrected from 200ms before stimulus presentation and up until stimulus presentation. The allowed amplitude was marked at -85 to 85 Hz with sections marked as bad 100ms before and after the artifact. Any activity lower than .05 Hz for longer than 200 ms was filtered out as well. The ERN was defined as the average activity between 0 - 200 ms post response at electrodes identified by visual inspection of the grand average waveforms (F3, F4, Fz, C3, C4, Cz, P3, P4, Pz, FC1, FC2, FCz).

TASK PERFORMANCE

Responses to Go/No-Go task were collected using DirectRT and MediaLab presentation software (Empirisoft Corporation, New York, NY). Participants' overall performance per condition and response accuracy was recorded. To account for the fact that the individual samples are not independent we accounted for within-pair variation in task performance by using

multi-level modeling to model change in Go/No-Go performance as a function of condition. Further, to relate task performance to trait competitiveness we ran a series of analyses, using average response times and response accuracy on the task and the average score on the Cooperative and Competitive Personality Scale. Finally, in order to explore whether differences in trait self control and personality might moderate the findings, we ran a series of correlations.

SELF-REPORT MEASURES

After having completed all three conditions, each participant was asked to fill out three questionnaires. The "Cooperative and Competitive Personality Scale" measures a person's personality tendency toward cooperative or competitive traits. The CCPS was created by Lu et al. (2006, 2011) using items from previously established cooperativeness and competitiveness scales. They found through a multilevel approach of reliability analysis that both cooperativeness and competitiveness are reliably measured with Cronbach's alphas of .87 and .85 respectively. The CCPS contains 23 items with 13 items pertaining to cooperativeness traits and the remaining 10 are about competitiveness. For each personality trait the items are divided into three subcategories: beliefs about the traits, behavioral tendencies of the traits, and feelings about the traits. Each item is scaled on a five point likert scale with 1 being 'not at all like me' and 5 being 'very much like me'. An example item for competitiveness beliefs is "I like competition because it gives me a chance to discover my own potential." (Lu et al.,2006,2011). An example of a cooperative belief item is "I believe having a good partner at work enables you to triumph over all your opponents." (Lu et al.,2006, 2011). Each participant receives a score per personality trait which is the average of their responses to all items per personality trait.

The "Self-Control Scale" created by Tangney et al. (2004) measures an individual's self-control ability by looking at individual differences in self-control and a broad spectrum of

behaviors as well. When this scale was created the internal consistency estimates of reliability for total self-control scale were at .89, which is good. They also established test-retest reliability by having participants take the test again and found a Chronbach's alpha of .89 and .87 with test and retest respectively. To account for this potential issue with the variability of the social desirability scores the finalized scale partitioned this portion out. The scale is scored on a five point likert scale with 1 being 'not very much' and 5 being 'very much so'. There are 36 items total with a score of 5 meaning high self-control and 1 meaning low self-control. An example of one of these items would be "I am able to work effectively towards long term goals." (Tangney et al., 2004). There are also 24 reverse scaled items throughout the survey with an example of one being " I do certain things that are bad for me, if they are fun." (Tangney et al., 2004). After taking the scale the participant score is considered the indicator of if they have a high threshold of self-control or not. The highest possible score would be 180, but if a participant scores over the 60th percentile they will be considered to have high levels of self-control for this study.

The "Big Five Inventory (BFI)" created by John, O. P., & Srivastava, S. (1999) which aims to measure an individual's personality along the lines of the big five personality attributes of extraversion vs. introversion, agreeableness vs. antagonism, conscientiousness vs. lack of direction, neuroticism vs. emotional stability, and openness vs. closeness to experience. It was found when creating this inventory that the Chronbach's alpha is .84 suggesting good reliability of the scale. The BFI like the other two scales is scored using a five point likert scale with 1 being "Disagree Strongly" and 5 being "Agree Strongly". Each of the 44 items are paired with each of the five personality attributes it indicates. For example one item which the participants are told to scale on the likert scale as they feel it pertains to themselves would be "Is easily distracted" (John, & Srivastava, 1999). This item is connected to agreeableness, meaning if a

participant scores highly (5) on this item and all others that pertain to this same personality trait, it indicates they are more agreeable.

RESULTS

GO/NO-GO PERFORMANCE ANALYSIS

Participant performance in the conditions (individual, competitive, and cooperative) as well as response accuracy (correct/incorrect) and response time (ms) was collected. Of the compiled behavioral data one pair, number 3, was excluded from analysis due to extreme data points preventing analysis, leaving n = 16. A look at the individual participant level showed no significant effects of incorrect responses between the conditions (p = .373) and no significant effect of response times for 'Go' responses per condition were found (p=.362). At the pair level (n=8) a simple main effect was found between the incorrect responses of the conditions [$F(1,7)$ = 6.762, p = .035], and a simple main effect was found between reaction time of the 'Go' response and conditions [F(1.78,3.805) = 38.57, p = .004]. A repeated measures multivariate analysis of variance (MANOVA) was used to analyze the data. The design of the analysis was 3 (condition: individual/cooperative/competitive) x 2 (response accuracy: correct/incorrect). Additional planned comparison and repeated measure-analysis of variance were also run between the reaction times per condition to determine speed of task performance, and to serve as an additional behavioral measure of the task. [2]

In the competitive condition participants made on average 9.38 ± 1.295 incorrect responses and 190.63 ± 1.295 correct responses, while on average they responded to the "Go" stimulus at 372.185 ± 7.47 milliseconds. In the cooperative condition on average participants

[2] All response time data underwent analysis for the presence of outliers. Two outlying data points were excluded from analysis due an influential effect on the distribution of data; individual testing room one of Pair #7, and Pair #4 in the competitive condition.

made 9.50 ± 5.357 incorrect responses and 190.50 ± 5.357 correct responses while responding to stimulus on average at a rate of 368.915 ± 10.29 milliseconds. In the individual condition participants in testing room one made 22.13 ± 10.075 incorrect responses and 177.88 ± 10.075 correct responses on average. In testing room one participants responded to the stimuli at an average rate of 207.245 ± 14.100 milliseconds. Finally, in the individual condition participants in testing room two made 6.25 ± .996 incorrect responses and 193.75 ± .996 correct responses on average. In room two participants responded to stimuli at an average rate of 239.92 ± 11.945 milliseconds.

It is found that there is a main effect of the condition participants performed the Go/No-Go task in, $F(1,7) = 49.00$, $p < .001$, partial $\eta^2 = .875$. These findings suggest that performance on the task was affected by the condition of participation. This was further evaluated by looking at the interaction between condition and response accuracy which was found to be significant, $F(1.301,9.106) = 24.481$, $p < .001$, partial $\eta^2 = .778$. This corroborates that participants' accuracy was affected by condition showing that errors are made at significantly different rates per condition with more errors made in the individual condition than either of the joint conditions.

A series of planned comparisons were conducted examining the differences between the specific conditions and response accuracy. The first comparison between response accuracy in the competitive and cooperative condition was non significant ($p = .442$, $p = .165$). This suggests that the manipulation of a competitive or cooperative condition did not have an effect on the outcome of participant performance. However, a planned comparison between the incorrect responses in the individual and the incorrect responses in both the competitive and cooperative conditions shows a marginally significant trend, $F(1,7) = 3.726$, $p = .095$. A planned comparison of the correct responses in the individual versus joint conditions shows a significant difference of

response accuracy, $F(1,7) = 95.408$, $p < .001$, partial $\eta^2 = .932$. These results suggest that there may be a difference between the conditions with both participants performing together in the same room, rather than at the same time but next-door to each other. Even though both participants met each other before participating in the game, and knew they were performing the same tasks simultaneously, there seems to be an effect of even a few feet of difference in location of participation. This suggests that the social aspect of the joint task plays a role in performance while participating together rather than separately.

Further planned comparisons were done to look at the specific joint conditions as they compare to the individual condition. The difference between incorrect responses in the competitive condition and those in the individual condition found no significant difference ($p=.111$). A marginally significant trend was seen in a comparison of incorrect responses in the cooperative versus individual conditions, $F(1,7) = 3.996$, $p = .086$. These two findings seem to suggest that simply while working with another person, rather than alone or in competition with them, performance is mediated by the social interaction.

Additional analysis revealed that for the correct responses in the competitive condition versus the individual condition there is a significant difference, $F(1,7) = 302.742$, $p <.001$, partial $\eta^2 = .937$, and the same is found for the correct responses in the cooperative condition versus the individual condition, $F(1,7) = 42.025$, $p < .001$, partial $\eta^2 = .857$. This provides evidence for the main effect of joint conditions collectively. Suggesting that the presence of another enhances the performance accuracy of participants, while when performing alone the accuracy decreased due to the lack of social facilitation.

Analysis of the response times within each condition showed a significant difference in the reaction times between the different conditions, $F(1.78,3.805) = 38.57$, $p = .004$, partial $\eta^2 =$

.928 . Further evaluation of these results shows that there is no significant difference in reaction time between the cooperative and competitive conditions (p= .726) again suggesting the manipulation of a competitive or cooperative condition was not affecting task performance. However, there was a significant difference of the reaction times between the competitive condition and the individual conditions [$F(1,7) = 66.940$, $p = .004$, partial $\eta^2 = .957$] as well as between the cooperative condition and the individual condition [$F(1,7) = 41.680$, $p = .008$, partial $\eta^2 = .933$]. It was also found through planned comparison that the reaction times of the cooperative and competitive conditions compared to the average reaction times in the individual condition there is a significant difference, $F(1,7) = 55.471$, $p = .005$, partial $\eta^2 = .949$. These findings show, in conjunction with the descriptive statistics, that participants perform significantly different in the presence of another participant compared to on their own. A look at the findings presented here suggests that participants perform significantly faster when alone rather than with another, but they are more accurate when with another.

SELF-REPORT ANALYSIS

A series of correlations were run using the data collected from the self-report scales, and the participant performance ratings for both condition (individual/cooperative/competitive), response accuracy, and response times. There were no significant correlations found between any of the conditions, response accuracy, or reaction times and the Self-Control Scale (Tangney et al. 2004) or the Big Five Personality Inventory (John, O. P., & Srivastava, S. 1999).

In regards to the CCPS (Lu et al., 2006, 2011) a significant positive correlation was found between the errors made in the individual condition testing room one and the competitive affect reported by participants (r = .772, p = .025). These results seem to suggest that as participants have higher competitive desires they are more likely to make errors when performing a task

alone. There was also a marginally significant positive correlation between individual incorrect responses in room one and reported competitive behavior ($r = .646$, $p = .083$). It follows that reported typical competitive behavior maybe actually causes more errors than correct responses. These findings point towards the idea that as competitiveness increases so does performance inaccuracy when performing a task alone. No significant correlations were found between either participant incorrect or correct responses in the competitive or cooperative conditions and the CCPS (Lu et al., 2013). There was a significant positive correlation between the reaction time in the competitive condition and the average competitive behavior score, $r = .729$, $p = .040$. This suggests that when competing at a task, participants who report typical competitive behavior perform faster but not more accurately than in cooperative or individual settings.

EEG/ERN ANALYSIS

Data from our EEG recording was cleaned and analyzed using BrainVision Analyzer (Brain Products, Munich, Germany). All cap channels were edited down to twelve (F3, F4, Fz, C3, C4, Cz, P3, P4, Pz, FC1, FC2, FCz) due to consistent noise from unessential electrodes, and to provide a comparison of central channels for the detection of ERN. For every participant pair a total of four EEG data files were recorded (n=36); one per each of the joint condition and one per testing room in the individual condition. Due to noisy data and technological difficulties 7 data files were excluded leaving $n = 29$. The criteria for data cleaning and segmentation were used based on previous research (Inzlicht & Gutsell, 2007; Riesel et al., 2013; Falkenstein et al., 2000; Gehring et al., 1993). The ERN was defined as the average activity between 0 - 200 ms post correct versus incorrect response. Segments within 0-200ms post correct responses and incorrect responses were created and evaluated for significant activity differences. The EEG was corrected for horizontal and vertical eye movements using semi-automatic channel inspection

filtered with a 25 Hz filter marking bad 100ms before and after artifact. The allowed amplitude was marked at -85 to 85 Hz with trials marked as bad 100ms before and after the artifact. Any activity lower than .05 Hz for longer than 200 ms was filtered out as well. Averages for all three conditions and response accuracy were calculated within the time frame of 0 – 150ms, and then used for data analysis.

Of the two electrodes of interest the FCz across all conditions showed an average of .523μV for incorrect responses and 2.256μV for correct responses. The electrode Cz across all conditions showed an average of 2.497μV for incorrect responses and 4.015μV for correct responses. It was found that in regards to these two electrodes there was a significant ERN waveform between response across all conditions, $F(1,28) = 6.401$, $p = .017$, partial $\eta^2 = .187$. This shows that ERN was in fact found between correct and incorrect responses due to the task, independent of condition of participation. Unfortunately planned comparisons of the electrode FCz by response accuracy and condition showed no significant difference ($p = .175$), and the same was found for the electrode Cz, ($p = .270$). This seems to suggest that there is no effect of condition on the ERN in the electrodes of interest. Correlational analysis also revealed no significant correlations with any of the trait measures of competitiveness.

DISCUSSION

The findings and trends that have begun to emerge through this study are exciting and informative. We have shown through this study that there is a difference between exerting self-control through the Go/No-Go task when in the presence of another or alone that effects task accuracy. The interaction of condition and response accuracy provides evidence that while exerting self control in a task, even as simple as the Go/No-Go, performance is mediated by the immediate presence of another.

We found that there was also a significant difference between response accuracy in the joint tasks when compared to the individual condition. This suggests that as participants perform the task alone or with another person as opposed to when they are alone their performance is driven by distinct motivations. While alone individuals might be intrinsically motivated to perform while with another they may be extrinsically motivated by the social aspect of the situation, and these differences in motivation can lead to differences in performance. Additional evidence for this is provided by the significant difference in correct responses between both joint conditions (competitive & cooperative) versus the individual condition. This trend suggests that the presence of another does contribute to accuracy and time spent to respond differently than while participants act alone, specifically suggesting that the presence of another person provides a type of social facilitation or influences on performance.

The results of our behavioral data in relation to the self-report measure of competitiveness are also interesting. The positive correlation between competitive effect and the error responses within the individual conditions suggests that competitive personality traits serve

as a distractor between self-control exertion and motivation to perform well. As participants report having higher competitive trait they perform worse on the self-control task. The competitive trait seems to serve as a distraction from task accuracy. The findings in regard to individual responses and reported competitive behavior and affect support this in that as the number of incorrect responses increases the reported competitive behavior and affect increases. Suggesting that as the competitiveness of an individual increases the number of errors also increases. It seems competitiveness serves as a distractor rather than an enhancement of task motivation when performing alone.

The finding that the reaction time in the competitive condition was positively correlated with competitive behavior scores suggests that the more competitive an individual is the more time they spend focusing on responding to the stimuli when competing. Competitiveness seems to enhance time spent to respond to the task, but it does not enhance the accuracy of task performance. Participants exert self-control more while alone, as shown through correct responses to the Go/No-Go task, when they are less competitive on a trait level overall. It seems that competitive traits actually distract from self-control accuracy, rather than enhance it.

In regards to our ERN data and analysis although a significant ERN was found at the two electrodes of interest (FCz and Cz) no differences between the conditions were found. We expected to find that there were significant differences between correct and incorrect responses simply because of the nature of the Go/No-Go task, but the lack of conditional differences as well suggests that our manipulation of condition setting was not as powerful as we had hoped. Our behavioral data suggests that there are differences in behavior on the Go/No-Go task in conditions with another person compared to alone, however this does not seem to cause a neurological difference in response to erroneous responses.

It is important to note the drop in sample size, from the original proposed 20 pairs to only 9. Proposing a sample size of 40 was quite ambitious for this type of within subject design study. However, because of the differences between the significance on the participant level versus the pair level ideally in the future more pairs would be collected. The small sample size of pairs means that violations of normality, homogeneity, and sphericity all had to be taken into account. In the future this study would be run with a total of 24 participants rather than 18 thus providing more power and significance to the findings. One reason for the small sample size was technical difficulties that occurred as the study was being run. Issues with the computer setups themselves happened unexpectedly creating a delay in study time, as well as a loss of data collected due to noisy channels and missing information. Ideally more pilot studies would have been run to avoid such technical difficulties in the future.

When we set out to do this study we hypothesized that competitive individuals will perform more accurately while exerting self-control, due to their motivation for success. But this study seems to suggest that the opposite is actually true: competitive individuals perform worse both when working on a task individually and when actually performing with another person. In the future, more participants are needed to provide evidence for how these trends may appear while competing against another person, and to link these behavioral findings to potential effects in ERN amplitude. Our findings suggest that teamwork may only work if the members of the team focus on group success rather than individual success.

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APPENDIX A
FIGURES AND TABLES

Figure 1: Average Correct and Incorrect Responses by Condition

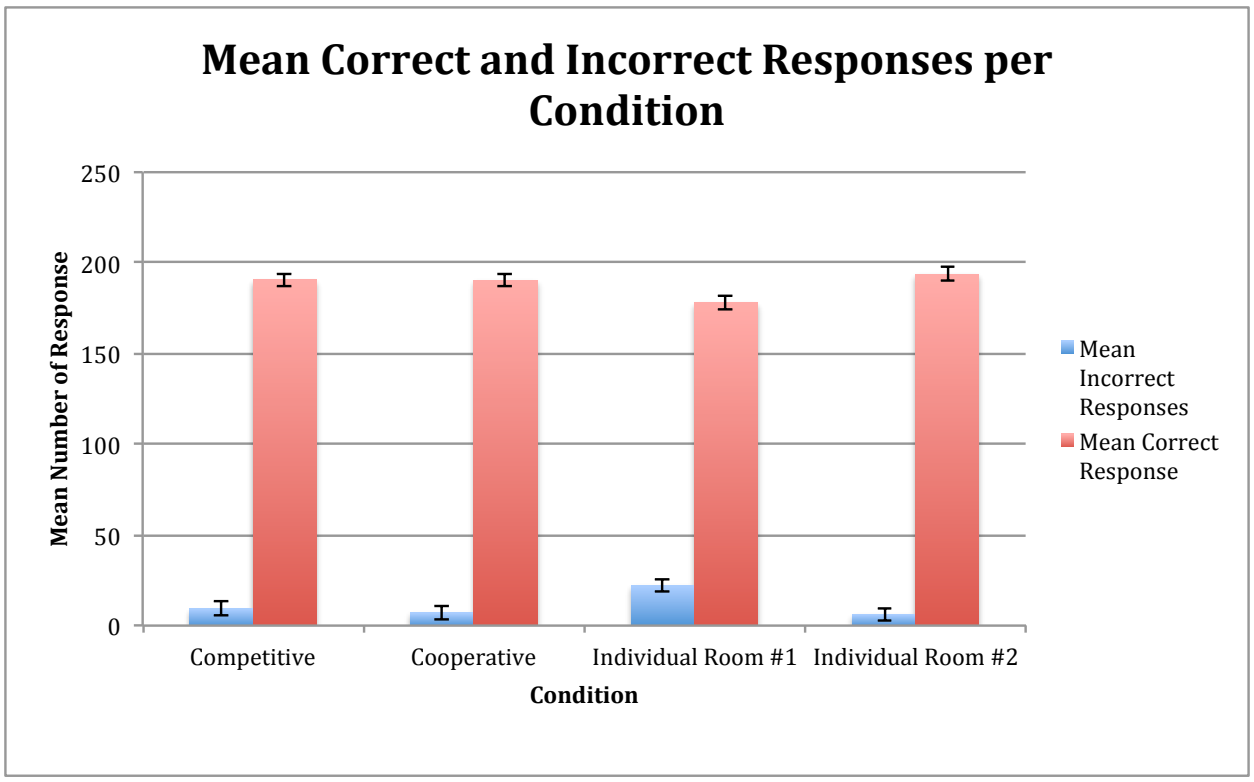

Figure 2: Average Response Time (ms) by Condition

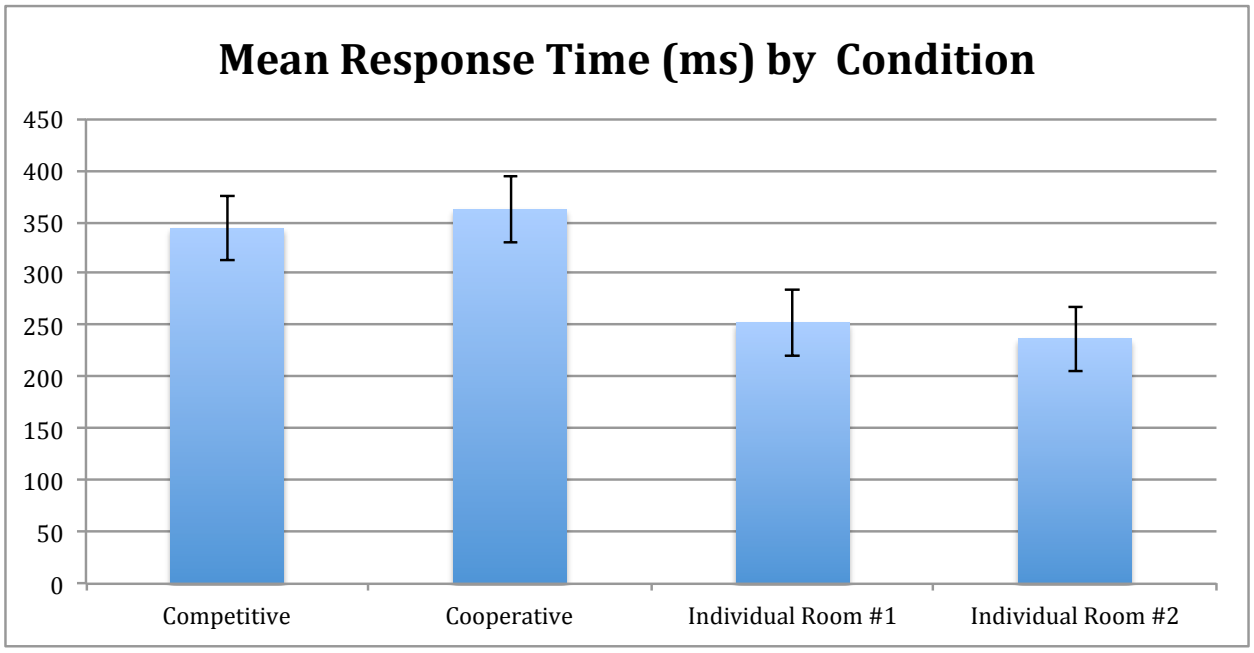

Table 1: Response Time per Condition by Average CCPS Scores

Response Time (ms) per Condition by Average CCPS Score

		Avg. Cooperative Beliefs	*Avg. Cooperative Behavior*	*Avg. Cooperative Affect*	*Avg. Competitive Behavior*	*Avg. Competitive Cognition*	*Avg. Competitive Affect*
Competitive Response Time	*r*	-0.075	-0.568	-0.321	**.729***	0.512	0.585
	Sig. (2-tailed)	0.86	0.141	0.439	**0.04**	0.195	0.128
	N	8	8	8	**8**	8	8
Cooperative Response Time	*r*	-0.362	-0.129	0.042	0.431	0.512	0.247
	Sig. (2-tailed)	0.378	0.761	0.921	0.287	0.195	0.555
	N	8	8	8	8	8	8
Individual Room #1 Response Time	*r*	-0.289	0.427	0.285	0.168	0.25	0.088
	Sig. (2-tailed)	0.487	0.291	0.494	0.69	0.55	0.835
	N	8	8	8	8	8	8
Individual Room #2 Response Time	*r*	0.199	-0.125	-0.149	0.216	0.072	-0.026
	Sig. (2-tailed)	0.637	0.768	0.725	0.608	0.865	0.952
	N	8	8	8	8	8	8

Table 2: Number of Incorrect Responses per Condition by Average CCPS Scores

Incorrect Responses per Condition by Average CCPS Scores

		Avg. Cooperative Beliefs	Avg. Cooperative Behavior	Avg. Cooperative Affect	Avg. Competitive Behavior	Avg. Competitive Cognition	Avg. Competitive Affect
Competitive Incorrect Responses	r	0.342	0.24	-0.084	-0.412	-0.528	-0.301
	Sig. (2-tailed)	0.407	0.567	0.844	0.310	0.179	0.469
	N	8	8	8	8	8	8
Cooperative Incorrect Responses	r	-0.525	-0.279	-0.593	-0.333	0.174	-0.234
	Sig. (2-tailed)	0.284	0.592	0.215	0.519	0.741	0.655
	N	6	6	6	6	6	6
Individual Room #1 Incorrect Responses	r	-0.036	-0.547	-0.552	0.646	0.159	**0.772***
	Sig. (2-tailed)	0.38	0.161	0.156	0.083	0.707	**0.025**
	N	8	8	8	8	8	**8**
Individual Room #2 Incorrect Responses	r	0.252	0.369	0.024	-0.318	-0.470	-0.049
	Sig. (2-tailed)	0.548	0.368	0.955	0.442	0.240	0.908
	N	8	8	8	8	8	8

Figure 3: Correlational Scatterplot

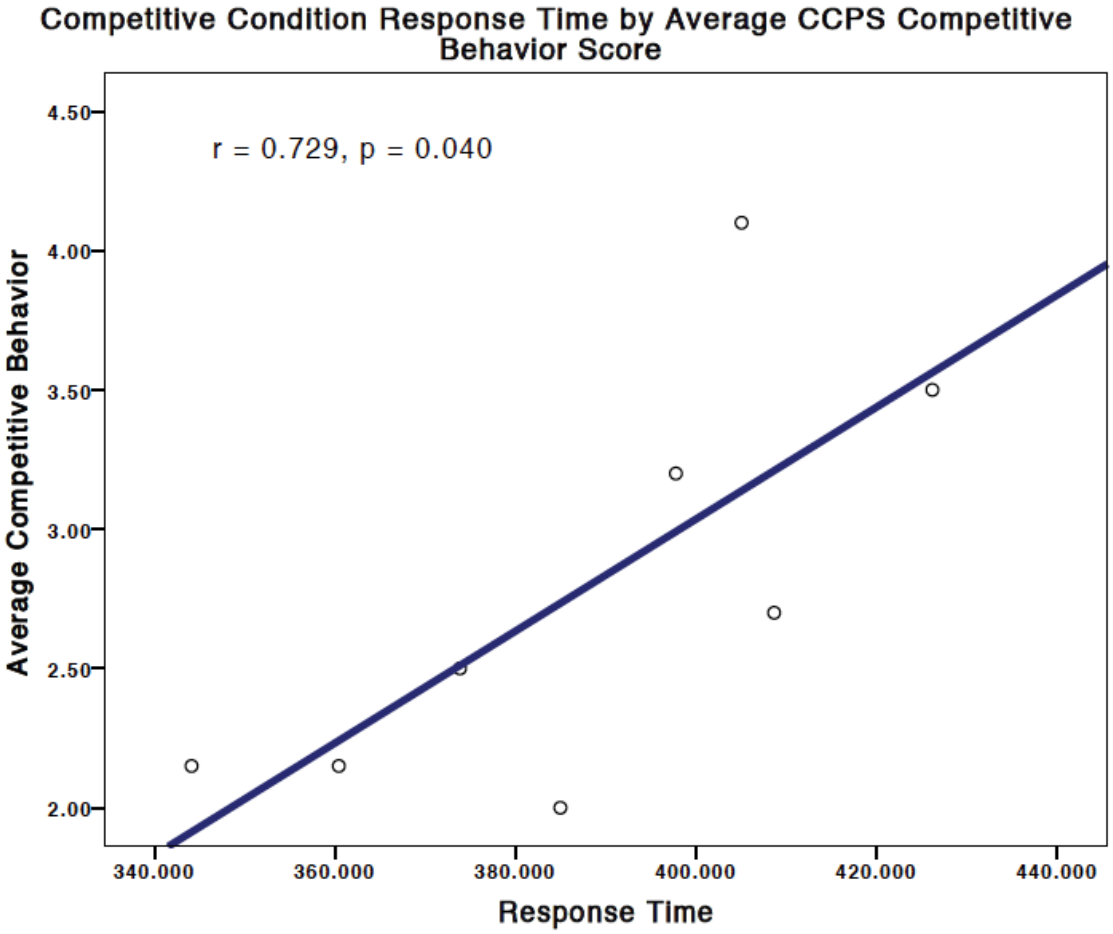

Figure 4: Correlational Scatterplot

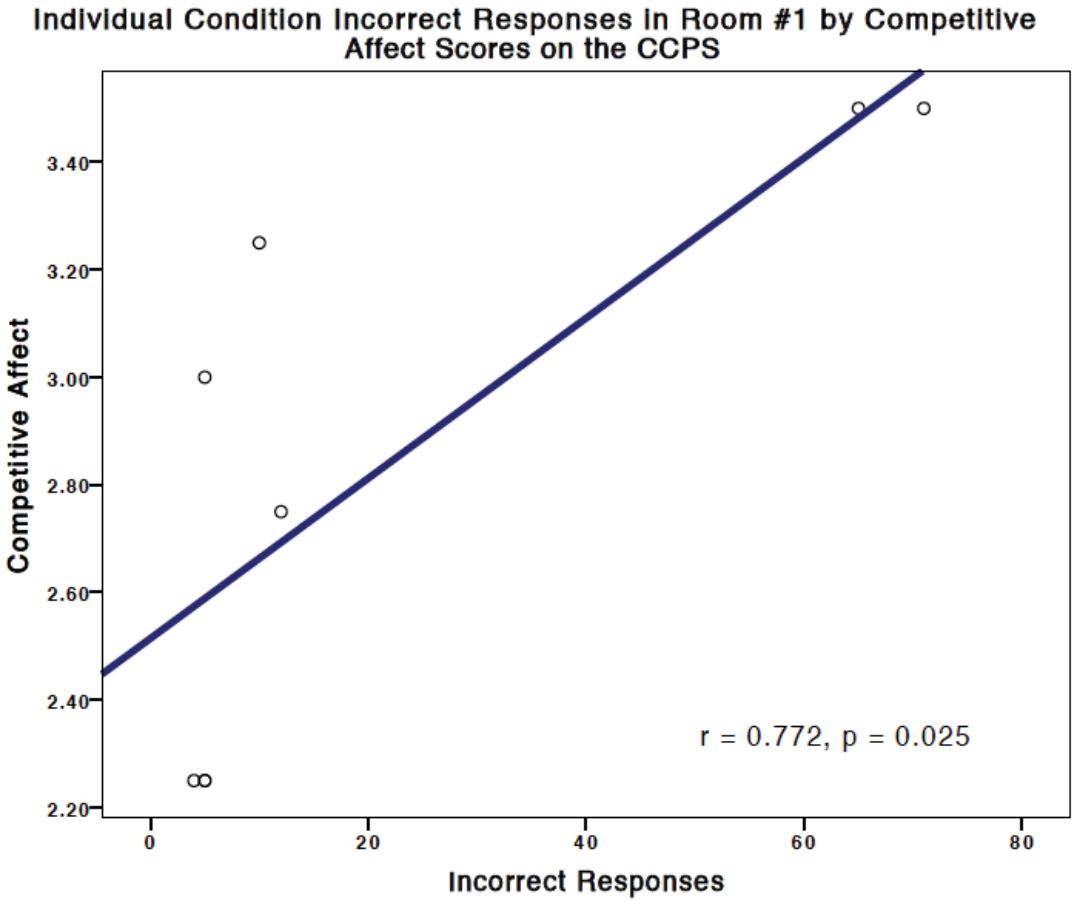

Figure 5: ERN Waveform of Electrode Cz

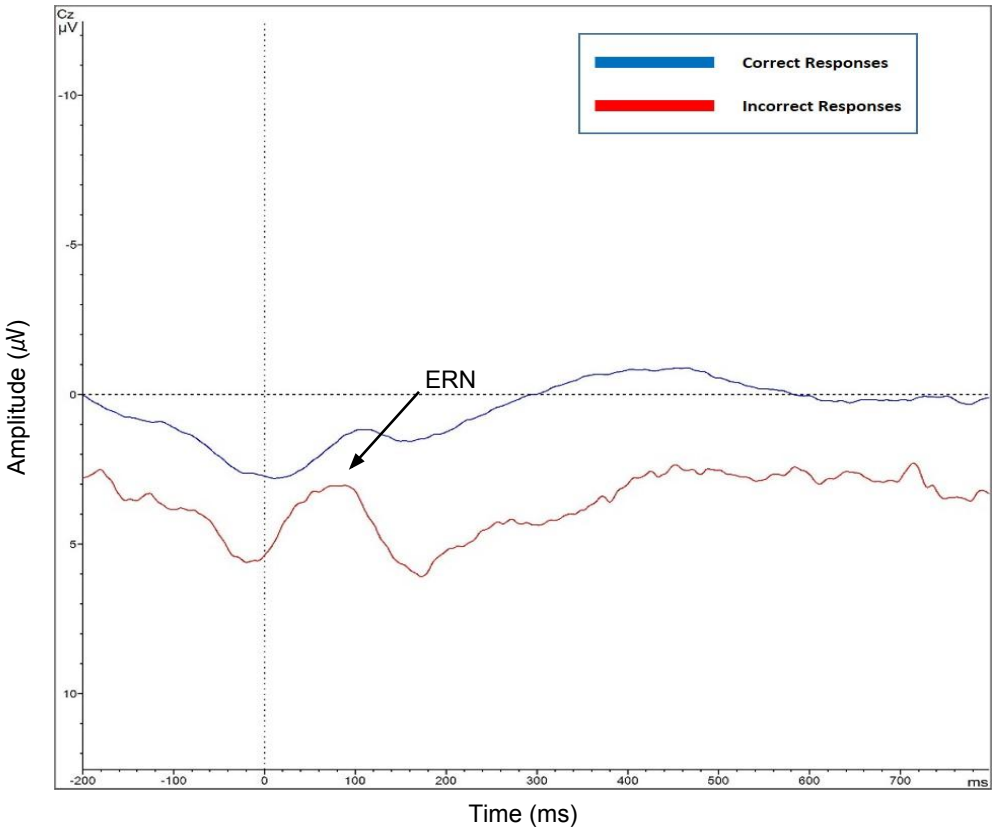

Figure 6: ERN Waveform for Electrode FCz