Spring 5-2016

Anxious Anticipation of a Social Threat and its Effect on Time Estimation

Natasha April Tonge
Washington University in St. Louis

WASHINGTON UNIVERSITY IN ST. LOUIS

Department of Psychological and Brain Sciences

Anxious Anticipation of a Social Threat and its Effect on Time Estimation

by
Natasha April Tonge

A thesis presented to the
Graduate School of Arts & Sciences
of Washington University in
partial fulfillment of the
requirements for the
degree of Master of Arts

May 2016
St. Louis, Missouri

Table of Contents

List of Figures

List of Tables

Acknowledgements

I would like to acknowledge Dr. Thomas L. Rodebaugh for his mentorship and support throughout this study. I would also like to acknowledge Clara Lee, Olivia Laing, and Emily Ness for their work on this project.

Natasha April Tonge

Washington University in St. Louis

May 2016

Dedicated to my mother, my brother and my grandparents.

ABSTRACT OF THE THESIS

Anxious Anticipation of a Social Threat and its Effect on Time Estimation

by

Natasha April Tonge

Master of Arts in Psychology

Washington University in St. Louis, 2016

Thomas L. Rodebaugh, Chair

Time perception is a well-studied phenomenon; however, subjective experience of time and its relationship to affective states has received comparatively less attention in the literature (Grondin, 2010). Recently, it was suggested that anticipatory anxiety may also lead to an overestimation effect regarding angry faces in socially anxious individuals (Jusyte et al., 2014). In the present study, participants completed two temporal bisection tasks (TBT) in which they were asked to categorize a stimulus as being of *short* or *long* duration. Between the tasks, participants were to present a speech that served to provoke anxiety. In the present study, I aimed to provide a conceptual replication and extension of previous findings by investigating temporal overestimation before and after the stressful event. I expected that individuals in the anticipatory anxiety manipulation condition (AAM) would overestimate stimulus durations relative to individuals in the no anticipatory anxiety manipulation condition (NAM) on the first TBT, but that this group difference would not be apparent on the second TBT. We also predicted that time overestimation would be significantly related to levels of anticipatory and trait anxiety.

Participants were 85 university students who were randomized into one of two conditions: the AAM condition or the NAM condition. Both groups performed the TBT, but the AAM group was repeatedly reminded that they would perform a speech after the TBT whereas the NAM group received no reminders.

The final sample for analysis consisted of 76 participants who completed all parts of the experiment and who did not differ by race, ethnicity, age, gender, trait anxiety, or baseline state anxiety (all *p*s > .11). The AAM group significantly overestimated time relative to the NAM group, $p = .030$, on the first TBT but not the second, $p = .332$. The anticipatory anxiety manipulation was inconclusive. Although there was a group by time interaction for negative affect, $p = .017$, there were no main effects of group or group by time interactions for the measure of anxiety, $p > .426$. Contrary to hypotheses, participants who were higher on trait social anxiety or more fearful of negative evaluation underestimated stimulus durations on the first TBT; however, only higher fear of negative evaluation explained performance on the second TBT.

The results of this study suggest a possible interaction between attention and arousal mechanisms modifying time estimation. Implications for the study of time estimation in relation to anticipatory anxiety fears are discussed.

Introduction

For individuals with social anxiety disorder, anticipation of a feared social event can activate a series of both cognitive and physiological responses. In their cognitive model of social phobia, Clark and Wells (1995) hypothesized that when faced with an anxiety provoking social event, highly anxious individuals would engage in more self-focused attention and negative evaluation that leads to and exacerbates awareness of physiological responses. This self-focused attention differs between high and low socially anxious individuals, and anticipatory anxiety is sustained in individuals with maladaptive cognitions about social stressors (Hinrichsen & Clark, 2003). The relationship between cognitive processing and the subjective experience among either individuals who experience high levels of social anxiety traits or individuals who have a diagnosis of social anxiety disorder has been explored in a number of domains: information processing biases, biased memory for threat cues, performance self-evaluation, and attention bias to threat are just a few examples of areas that have been extensively researched (Bar-Haim, Kerem, Lamy, & Zakay, 2010; Clark & McManus, 2002; Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Mansell & Clark, 1999; Rapee & Lim, 1992; Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994). Findings largely support the hypothesis that individuals with social anxiety disorder have self-perception and attention processes biased toward negative stimuli and away from positive stimuli. One domain that has received relatively little research attention, however, is the cognitive process of time perception and its relationship to social anxiety.

Anecdotal reports of time slowing down when in life-threatening situations, as well as colloquialisms like “time flies when you’re having fun,” capture the subjective components of the experience of time while also alluding to the effect of physiological and emotional experiences on time perception. Individual differences in the estimation of time have been studied extensively; however, variation in the subjective experience of time due to affective states has garnered only recent attention in the time perception literature (Grondin, 2010). Within the current literature on the effect of emotion on individual differences in subjective experience of time, arousal, and to a lesser extent, attention, have been identified as possible mechanisms through which perception is altered (Angrilli, Cherubini, Pavese, & Mantredini, 1997; Tipples, 2008).

According to the Attentional Gate Model of time perception (AGM; Zakay & Block, 1995) the subjective experience of time is dependent on the interaction between 4 elements: a pacemaker, an attentional gate, a switch, and an accumulator. When a timing event occurs, the pacemaker emits pulses that are routed through the attentional gate. Pulses proceed to the switch and are finally counted in an accumulator, or cognitive counter. As the number of pulses reaching the accumulator increases, time appears to move more slowly. The frequency of pulses can be increased either as a result of increased pulses being generated by the pacemaker or an increased number of pulses passing through an open attentional gate. The pacemaker is modified by arousal states (higher arousal leading to increased pulse frequency) and the attentional gate is modified by attention (increased attentional resources devoted to timing leading to an open gate). Taken together, time overestimation, as might be observed by an individual having a near-death experience, can be explained by heightened arousal and heightened attentional resources being allocated to noticing the passage of time. This model provides the theoretical basis for the study of the effect of an emotional state like anxiety on time perception (Bar-Haim et al., 2010; Gil & Droit-Volet, 2009).

Traditionally, fluctuations in the accuracy of time judgments have largely been assumed to have an adaptive function (Droit-Volet & Gil, 2009). However, some evidence examining the function of time perception in individuals with psychopathology suggests individual differences in time perception mechanisms and potential maladaptive manifestations. For example, among individuals with high trait levels of anxiety, such as those with spider phobia, overestimation of time is associated with a high arousal state resulting from confrontation with the phobic stimulus (Watson & Sharrock, 1984). Such reactions can be explained as immediate responses in acutely dangerous situations; however, the consistently higher levels of anxiety occurring before, during, and after a negative event that are experienced by highly anxious individuals (Clark & Wells, 1995; Hinrichsen & Clark, 2003) may be outside of the range in which time overestimation is adaptive. Furthermore, overestimation of the duration of the negative event might compound the negative affect associated with that event. As both arousal and attention mechanisms have been reported to differ in individuals who are highly socially anxious (Bar-Haim et al., 2010; Hinrichsen & Clark, 2003), it is likely that subjective experiences of time would also differ. Knowing the full extent of the effect of anxiety on time estimation might have important implications for understanding subjective experiences that might aggravate highly anxious individuals' processing of negative events. For example, many individuals with the performance subtype of social anxiety disorder experience marked distress surrounding exposure to giving speeches or talking in front of a group of people. According to the AGM, modifying the focus of attention or arousal for these individuals should affect their experience of the passage of time, which might in turn affect their experience of exposure to the feared event.

Many studies have used a paradigm known as a temporal bisection task (TBT) in order to explore normative perception of time, as well as the effects of psychopathology, arousal, and emotion on individual tendencies to over- or underestimate the passage of time (Bar-Haim et al., 2010; Droit-Volet & Meck, 2007; Tipples, 2008). In a TBT, participants are presented with stimuli and asked to identify the stimuli as either of a short or long duration. Participants are trained on two, easily distinguishable anchor stimulus durations, then given several stimuli with durations falling between the two anchors that they must label as short or long. Ordinarily, humans show little variation in the ability to classify the anchor durations and they show the most ambivalence in labeling the midpoint duration (Kopec & Brody, 2010). In other words, at the arithmetic mean of the anchor stimulus durations, humans are as likely to label the stimulus "short" as they are "long." Over- or underestimation can then be said to occur when the duration with the most ambiguity is closer to the short anchor or closer to the long anchor, respectively. Only a handful of studies, relative to the immense body of literature on human time perception, have demonstrated that perception of time can be subjectively altered depending on an individual's psychopathology or by stimuli displaying negative emotion (see Grondin, 2010 for review); the evidence of the effect of anticipatory anxiety of a feared social event on the overestimation of time is limited to just a single study. Jusyte and colleagues (2015) compared college students diagnosed with social anxiety disorder to a control group of low-anxious students on a time perception task. Participants were asked to estimate the duration of a stimulus before and after experimentally induced anticipatory anxiety about a speech. Individuals who were diagnosed with social anxiety disorder significantly overestimated the duration of the stimulus after the speech provocation compared to undiagnosed individuals.

The current study is an effort to provide a conceptual replication demonstrating the time overestimation effect caused by experimentally induced anticipatory anxiety. A second aim is to extend the previous findings by exploring what effect, if any, a socially stressful event has on time perception after the event has been completed. Based on previous studies, I expected that the group with experimentally induced anticipatory anxiety (AAM group) would overestimate stimulus durations on the first task relative to the group who did not have anticipatory anxiety manipulated (NAM group). I expected to also see a relationship between task performance and anticipatory anxiety such that self-reported changes in anxiety would be predictive of the amount of overestimation. After the conclusion of the stressful event, I expected that there would be no difference between the AAM and NAM groups; however, I expected that individuals who reported either more concerns related to their speech performance or who continued to report higher levels of state anxiety following the speech would overestimate time relative to individuals with lower anxiety or fewer concerns about speech performance.

Method

Participants

Participants were undergraduate psychology students who received course credit for their participation. No exclusion criteria were utilized. Participants received course credit for their research participation. The study was approved by the institutional review board at Washington University in St. Louis. Before the participant arrived, he or she was randomized using a random number generator into one of two conditions: the anticipatory anxiety manipulation group (AAM) or no-anticipatory anxiety manipulation group (NAM). After consent was obtained, all participants were asked to complete several questionnaires including demographic and trait anxiety measures that are described below.

Measures

The Anticipatory Social Behaviours Questionnaire (ASBQ*;* Mills, Grant, Lechner, & Judah, 2013). The ASBQ is a 12-item self-report measure of anticipatory social behavior. Items range from 1 (*Never*) to 4 (*Always*). Exploratory factor analysis suggested a two-factor model with Avoidance and Preparation as factors comprised of 10 of the 12 items, and a confirmatory factor analysis yielded good fit indices for a two-factor solution. The overall measure (ASBQtotal) and the Preparation subscale (ASBQprep) had good internal consistency (α = .83 and α = .82, respectively) and the Avoidance subscale (ASBQavoid) had adequate internal consistency (α = .73). Both factors were well-correlated with other self-report measures of anxiety, but only the ASBQAvoid predicted social anxiety symptoms as measured by the Social Phobia Scale (Mills, Grant, Lechner & Judah, 2013). In this study, internal consistency was similar to Mills and colleagues (2013) on the ASBQtotal (α = .84) and ASBQavoid (α = .76), whereas internal consistency on the ASBQprep subscale was only adequate (α = .74).

The Social Phobia Scale (SPS; Mattick & Clarke, 1998). The SPS is a 20-item self-report measure of performance fears and fear of scrutiny. Items were scored on a 5-point Likert scale ranging from 0 (*not at all*) to 4 (*extremely*). Mattick & Clarke (1998) reported several tests of the reliability and validity of the SPS. They reported that the scale has high test-retest reliability over 3-5 week and 11-12 week time periods (r = .91 and .93, respectively). The measure also has high internal consistency among both clinical and non-clinical samples (α = .89 and .90, respectively). The authors demonstrated the validity of the SPS by correlating the scale with other established measures of fear of negative evaluation and social anxiety. They found that the relationship between SPS and fear of negative evaluation persisted when variation due to general distress was partialled out. The scale has also been shown to predict anxious response to a social threat (Gore, Carter, & Parker, 2002). In the current study, internal consistency was excellent (α = .91).

The Brief Fear of Negative Evaluation (BFNE; Leary, 1983). The BFNE is a 12-item version of the original Fear of Negative Evaluation scale that employs a 5-point Likert scale (1 =

not at all characteristic of me; 5 = extremely characteristic of me). The brief version of the scale correlated very highly with the full length version of the scale, $r = .96$, and internal consistency was excellent, $\alpha = .90$ (Leary, 1983). Use of the shorter version of the scale was supported in a study by Rodebaugh and colleagues (2004), who found that the BFNE was better able to discriminate fear of negative evaluation at a wider variety of severity levels compared to the full length Fear of Negative Evaluation scale. Furthermore, the authors found that the straightforwardly-worded items of the BFNE were better predictors of other self-reported social anxiety measures. As a result, only the straightforwardly-worded items from the BFNE will be used here. In this sample, internal consistency of these items was excellent ($\alpha = .92$).

The Brief State Anxiety Measure (BSAM; Berg, Shapiro, Chambless, & Ahrens, 1998). The BSAM is a 6-item version of the State-Trait Anxiety Inventory (STAI; Spielberger, 1983). As Berg and colleagues (1998) reported, the BSAM is comprised of the 6 items on the STAI with the highest item-to-item remainder correlations and is highly correlated with the 20-item version of the STAI ($r = .93$). They also found internal consistency of the BSAM to be good ($\alpha = .86$). In the current sample, the BSAM was administered four times and values of internal consistency ranged from fair to good (αs = .75-.89).

The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS is a 20-item self-report questionnaire comprised of two factors: positive (PANAS-PA) and negative (PANAS-NA) activated affect. In this study, participants were administered instructions to complete the measure keeping in mind what was generally true of how they felt (trait-like positive and negative activated affect) at the beginning of the study and instructions for how they felt in the moment (state-like positive and negative activated affect) at 4 time points during the study. Items for both sets of instructions did not vary and ranged on a 5-point Likert scale from 1 (*very slightly or not at all*) to 5 (*extremely*). The responses to the PANAS-NA were the focus of analysis here, as items within this subscale have been shown to measure negative *activated* affect (e.g., being actively *tense* as opposed to passively *depressed*). Although only one subscale was the sole focus of analysis, Watson and colleagues (1988) reported that state forms of both scales had good alpha reliability (PANAS-PA: $\alpha = .89$; PANAS-NA: $\alpha = .85$) and the trait form of the PANAS-NA subscale was shown to be highly, positively correlated with the STAI ($r = .51$). Additionally, regression analyses conducted by Dyck, Jolly, and Kramer (1994) demonstrated that the PANAS-NA subscale significantly predicted self-reported anxiety in a psychiatric outpatient sample. Within our sample, internal consistency of the trait form of the PANAS-NA subscale was good ($\alpha = .88$).

The Speech Assessment Questionnaire (SAQ). The SAQ is a measure created for this study as a means of assessing participant discomfort giving their speech. There were three items rated on a scale of -3 to 3, with lower numbers indicating more dislike, nervousness, or experience of difficulty giving the speech: *How much did you like giving this speech?*, *How nervous did you feel about giving this speech?,* and *How difficult was it for you to give this speech?* Internal consistency was good ($\alpha = .77$) and the measure was significantly and negatively correlated with the BFNE, $r = -.26$, $p = .014$, indicating that individuals with higher fear of negative evaluation scores experienced more discomfort giving the speech.

Procedure

The experiment consisted of three stages: a temporal bisection task (TBT1), a speech task, and a second temporal bisection task (TBT2). Before each stage of the experiment, the participant completed the BSAM.

Temporal Bisection Task - Time 1

The TBT was preceded by a 10-trial training and consisted of 84 experimental trials divided into 3 blocks. The experimenter read the instructions to the participant aloud. For the training trials, participants were presented with an image of an oval and informed that the oval could be on the screen for a long amount of time (1600 ms) or a short amount of time (400 ms). These two durations represented easily distinguishable anchor durations. Participants then indicated whether the image was of short or long duration using the “d” key or the “k” keys on the keyboard. Whether the “d” key indicated a short or long duration was randomized across participants independent of their group assignment, and this key assignment was used throughout the experiment. Participants were told that during the experimental trials, there would be a picture of a face instead of an oval and that they were to indicate whether the image was closer to the short or to the long duration they had just learned. Although all participants were notified that the experiment involved giving a speech, the experimenter only reminded participants in the AAM condition that they would be giving a speech as soon as the computer task was complete; participants in the NAM condition did not receive this explicit reminder. The experimenter then left the room.

On the experimental trials, an image of a face with a neutral expression was presented at the two trained anchor durations of 400 and 1600 ms, and at new untrained durations of 600, 800, 1000, 1200, 1400 ms. Within each block, each stimulus duration occurred 3 times. Via a computer message, participants in the AAM condition were told the number of blocks remaining before they would have to give their speech whereas participants in the NAM were simply told how many blocks remained before the end of the task.

Speech Task

Due, in part, to the decision to avoid deceiving participants, all participants completed the speech task. The results of the task will not be discussed here, as its primary purpose was to follow through with the threat of a social stressor and to observe the effect the occurrence of that stressor had on task performance after its conclusion. The participants were led into a different room and given 7 minutes to prepare a speech based on a list of topics. They were informed that the speech could last up to 10 minutes and that they should prepare for the speech with that duration in mind. The experimenter then left the room and returned at the end of 7 minutes. Participants were asked to stand as they delivered their speech to the experimenter, who was instructed to maintain a neutral expression for the duration of the speech. The experimenter interrupted the participant's speech at 3 time points (at approximately 1, 3, and 5 minutes) and asked participants to estimate how much time had passed since they began speaking. Speeches concluded after that final prompt from the experimenter, approximately 5 minutes after the beginning of the speech.

Temporal Bisection Task - Time 2

Participants repeated the 10 practice trials prior to the second TBT. The second temporal bisection task was identical to the first, with the exception that both groups were told the number of blocks remaining before the end of the computer task. Key assignment remained the same as in Task 1.

Data Analytic Procedure

Due to differences between groups on one measure of trait anxiety (see **Results**), the groups were equalized using a matching procedure that consisted of eliminating the individual from the NAM group, the group with more variation in score, with an SPS score that was the most extremely different from any individual in the AAM group. The groups were then retested for differences and the procedure was repeated until the groups were statistically equivalent. Four individuals were removed from the NAM group in this manner. To equalize groups on the PANAS-NA, two individuals in the NAM group who scored 5 points or greater than the highest scoring individual in the AAM group were also removed. One participant who declined to participate in the speech task was excluded from analysis. The final sample for analysis consisted of 40 individuals in the AAM group and 36 in the NAM group. Their demographic information is provided in Table 1. After matching, differences between groups on the questionnaires were statistically non-significant. Results will be discussed in terms of the matched samples; analyses conducted with the unmatched sample will be provided as a footnote when those results differ from the matched sample.

Change scores were calculated to indicate participants' levels of subjective distress relative to their baseline measures of anxiety. The first set of change scores were for the BSAM and PANAS-NA between baseline measurement and immediately after the first task (ΔAnxiety1 and ΔNA1, respectively). The second set of change scores were between baseline measurement and immediately after the speech (ΔAnxiety2 and ΔNA2). The first set of change scores was meant to measure the change in distress that could represent a state-level anticipatory anxiety whereas the second represented distress after having completed the speech.

Individual trials were eliminated from both Time 1 and Time 2 tasks if participant reaction times were slower than or equal to 2 standard deviations above the group mean, or quicker than or equal to 200 ms. The lower bound was chosen as it is faster than participants would likely be able to process stimuli (Whelan, 2008). Trials eliminated in this way were minimal: 4.26% of trials were eliminated from Time 1 and 3.48% of trials from Time 2.

Two outcome variables were calculated that described computer task performance. The first outcome variable was the bisection point, defined as the hypothetical stimulus duration at which participants' proportion of "long" responses was equal to .5. Participants who overestimated time were expected to have bisection point values at stimulus durations less than the arithmetic mean of the 7 stimulus durations (1000 ms; Kopec & Brody, 2010). The bisection point was calculated for each participant at both time points.

The second outcome variable calculated was d', using the method described in Kramer and colleagues (2013). The d' statistic provides an index of difference between the two time points and provides a means of assessing participant performance across time points. The proportion of long responses was calculated for each participant, at each stimulus duration, and was then transformed into a *z*-score using the probit function. The *z*-scores for Time 1 were subtracted from *z*-scores for Time 2 to yield 7 d' values, and these scores were then averaged to provide a single index of task performance.

In all analyses, significance was determined at $p = .05$. Trends are neither interpreted nor discussed due to the number of regression analyses utilized to explain task performance.

Results

Participant Characteristics

A total of 85 participants completed the study. Groups did not differ on race, ethnicity, level of education, or age (all *p*s > .11). Groups also did not differ on the PSP, SAQ, or ASBQ (*p*s > .450); however, they significantly differed on the SPS ($p = .022$) and there was a trend-level difference between groups on state version of the PANAS-NA at baseline measurement (*p*

= .061; see Table 2). After the groups were matched using the procedure detailed in the **Data Analytic Plan** above, there were no group differences, *ps* > .011, and the remaining 76 participants were included in the final analyses. Participants were between the ages of 18 and 23 (*M* = 19.5, *SD* = 1.3). They were primarily women (62.4%) and primarily non-hispanic (92.9%). More participants identified as white (49.4%) than any other race. Demographic information is provided in Table 1 for both the full sample (unmatched) and reduced sample (matched).

Manipulation Check

To determine whether the anticipatory anxiety manipulation successfully led to an increase in anxiety or negative affect after the first task but before the speech, two 2 (Group: AAM and NAM) x 2 (Time: baseline and following the first TBT) mixed model ANOVAs were conducted. The first ANOVA examining anxiety as measured by the BSAM resulted in a main effect of time, $F(1,73) = 6.83$, $p = .011$, but no main effects of group or a Group x Time interaction, *p*s > .426. The second ANOVA was conducted examining negative affect using the PANAS-NA; there were no main effects of group, but there was a Group x Time interaction, $F(1,72) = 5.93$, $p = .017$. Post-hoc *t*-tests revealed that on the PANAS-NA, there was a trend-level increase in negative affect for participants in the AAM group ($p = .093$), but a trend-level decrease in negative affect for participants in the NAM group ($p = .090$). The between group differences at baseline and after the first task were not significant, *p*s > .152. Within the unmatched dataset, this pattern of results was identical.

The unexpected difference in the results of the anxiety and negative affect measure creates difficulties with the interpretation of the effect of the manipulation. A group by time interaction was predicted for both negative affect and anxiety because it was expected that the change in these affective states would be specific to the AAM group. In actuality, both groups showed an increase in anxiety over time and the group by time interaction was only present when negative affect was the dependent variable. As a result of these mixed findings with respect to the success of the experimental manipulation, I focused further analyses on the exploration of traits related to social anxiety that might still be related to participants' performance on the time estimation tasks.

Time 1 - Bisection Point

Groups differed significantly on bisection point, $t(74)=2.21$, $p = .030$, such that individuals in the AAM condition ($M = 881.99$, $SD = 109.27$) overestimated time relative to individuals in the NAM condition ($M = 940.15$, $SD = 120.41$). The proportion of long responses for each group at each of the 7 stimulus durations, illustrated in Figure 1, demonstrates this effect. Whether state or trait-level variables were related to task performance at Time 1 was explored using five multiple regressions to explore the effect of each of the following five predictors on task performance (i.e., the bisection point): the BFNE, the SPS, ASBQ total score (ASBQtotal), avoidance subscale (ASBQavoid), and preparation (ASBQprep) subscales. These five variables will be referred to as *focal predictors*, as they were the primary focus of the analysis and subsequent interpretations. Group, key assignment, and the difference between baseline BSAM responses and responses after the task (ΔAnxiety1) were entered in each of the five regressions to account for the effects of group assignment, randomization of response keys (i.e., whether "d" indicated "short" or "long"), and individual differences in ΔAnxiety. Of the five focal predictors, the BFNE, $p = .028$, and SPS, $p = .042$, showed a significant relationship with task performance. Further, this relationship with bisection point was positive, suggesting that individuals engaged in more fearful thought patterns concerning the upcoming speech task or who were higher on trait anxiety were more likely to identify stimuli as being closer to the “short” anchor (i.e., the bisection point was higher). In the regressions in which the ASBQtotal, the ASBQprep subscale, and SPS were focal predictors, there were significant main effects of group, $p = .029$, $p = .047$, and $p = .050$, respectively. There were no other main effects of other focal predictors nor any significant interactions, *p*s > .070.

Accounting for ΔNA1 as a predictor rather than ΔAnxiety1 but keeping all other predictors the same in each of five regressions resulted in a significant main effect of BFNE ($p = .016$) with a positive relationship with task performance. Unlike when ΔAnxiety1 was accounted for, there were no main effects of the SPS or group assignment.[1]

Time 2 - Bisection Point

Unlike at Time 1, groups did not differ on bisection point, $t(74) = .975$, $p = .332$; Figure 2 illustrates this finding using proportion of “long” responses at each of the 7 stimulus durations. Four separate multiple regression analyses were performed to investigate the relationship between BP at Time 2 and each of the following four focal predictors: the BFNE, the SPS, the

[1]Results differed within the unmatched sample when the SPS was the focal predictor and ΔAnxiety1, group and key assignment were also entered as predictors in that there were significant interactions of ΔAnxiety1 x Group, $p = .029$, SPS x ΔAnxiety1 x Group, $p = .039$, and SPS x ΔAnxiety1 x Group x Key Assignment, $p = .026$. When ΔNA1 replaced ΔAnxiety1 as a predictor, results within the unmatched sample differed in two places: first, there was a significant ASBQprep x Key Assignment, $p = .031$; and, second, there was a significant main effect of group when the ASBQavoid subscale was the focal predictor, $p = .032$. The potential significance of these findings will be addressed in the **Discussion**.

SAQ, and the PSP. The ASBQ and its subscales were excluded from analyses at this stage because anticipation of the speech was no longer relevant as the speech was already completed by this point. The SAQ and PSP were used instead as measures of self-assessed speech performance. Group, key assignment, and ΔAnxiety2 were again accounted for in each regression. There were no main effects or interactions present that significantly predicted bisection point at Time 2, *p*s > .067. Examining ΔNA2 instead of ΔAnxiety2 resulted in a significant main effect of BFNE, $p = .033$, and a significant Group x Key Assignment x BFNE interaction, $p = .024$.

To investigate the 3-way interaction, an analysis of the simple slopes was conducted according to methods described by Dawson & Richter (2006). Here, the effect of BFNE on bisection point was the focal predictor, with group and key assignment being included as moderating variables. The effect of BFNE on bisection point led to underestimation in the AAM group in one key assignment condition ("d" indicates "short") but not the other ("k" indicates "short"), $p = .050$. The simple slope for the effect of BFNE when moderated by the "d" condition and the AAM condition was significantly different from 0, $p = .036$. This finding suggests that in the AAM condition, the difference between the performance of individuals with low and high trait fear of negative evaluation is moderated by key assignment. This effect was not hypothesized, and similar interaction effects were not available in the literature for comparison (see **Discussion**).[2]

---

[2]Results within the unmatched data set were similar to findings in the matched data set except for a significant Group x Key Assignment x BFNE interaction when ΔAnxiety2 was accounted for, $p = .016$. When ΔNA2 was accounted for, there was a significant SAQ x Group interaction, $p = .037$, and when BFNE was the focal predictor, there was a significant ΔNA2 x

The d' Value as an Outcome Variable

A single d' value that was computed from the average d' of all 7 durations was tested against 0 to provide an indication of whether or not participants changed in their tendency to over- or underestimate across Time 1 and Time 2. *T*-tests revealed that there was a significant difference from 0 in the NAM group ($t(35) = 2.80$, $p = .008$), but not in the AAM group ($t(39) = 1.16$, $p = .253$) such that, within the NAM group, participants overestimated at Time 2 relative to Time 1. In an effort to explain this difference, three regressions were conducted using the BFNE, SAQ, and the PSP to predict the average d' value; group and ΔAnxiety2 were entered as moderating variables. There were no significant main effects or interactions predicting d' (*p*s > .180). When the ΔNA2 replaced ΔAnxiety2, no significant main effects or interactions were found (*p*s > .190).

Key Assignment interaction, $p = .040$. A simple slope analysis revealed that SAQ x Group interaction was comprised of two trend-level slopes: higher SAQ scores led to underestimation only in the AAM group. The ΔNA2 x Key Assignment interaction was such that changing response keys led to underestimation only in individuals with increased negative affect relative to baseline. The SAQ x Group interaction was reduced to a trend-level effect in the matched sample. The effect of ΔNA2 x Key Assignment, on the other hand, was not present at the trend-level in the matched data set. The potential significance of these findings will be addressed in the discussion section.

Discussion

The primary aim of this study was to investigate the effect of experimentally manipulated anticipatory anxiety on time estimation. The manipulation check demonstrated that anxiety increased between baseline and after the first task for both groups, but there was no group by time interaction for anxiety; a group by time interaction that was not hypothesized did exist for negative affect, however. Similarly to the results of Jusyte and colleagues (2014), individuals in the AAM group were shown to overestimate the duration of stimuli presented at the mean stimulus duration relative to the NAM group after the mood induction. My results indicated that relative underestimation, not overestimation as hypothesized, was related to higher trait anxiety and fear of negative evaluation. Furthermore, groups no longer differed after the speech was over in terms of their bisection point, but this lack of group difference appeared to be due to the fact that the NAM group more closely resembled the AAM group in terms of response pattern at Time 2. This result was against hypothesis because the resolution of the stressful event was predicted to have resulted in decreases in arousal and thus the NAM group would estimate similarly at Time 1 and Time 2 and the AAM group would underestimate relative to their initial task performance.

It should be noted that the a priori hypotheses guiding this study were generated based on relatively few prior studies of anticipation of social threat. Although the results of the current study were against hypotheses, the consistency with which underestimation was related to fear of negative evaluation in the current study prompts a re-examination of findings in previous studies. Interpretation of the current findings may be speculative, but they importantly prompt for the generation of new hypotheses that might serve to guide future, more definitive research of time estimation mechanisms as they relate to the experience of anticipatory social anxiety.

Particularly worthy of further exploration is the finding that fear of negative evaluation predicted underestimation in terms of time estimation, which suggests that perhaps arousal, previously hypothesized to be the primary mechanism at work (Bar-Haim, Kerem, Lamy, & Zakay, 2010; Jusyte, Schneidt, & Schönenberg, 2015; Tipples, 2008), may give way to attention as the primary mechanism at work under certain conditions. For example, a participant who is more attentive to the task or to the passage of time would still overestimate time, whereas a participant who is occasionally preoccupied with the upcoming speech and occasionally diverts attention toward that future goal would be splitting attentional resources and thus underestimate.

Such a role for attention mechanisms has been proposed in studies of human timing in which anxiety is not being manipulated (Droit-Volet & Meck, 2007), but other researchers have proposed a slightly different mechanism at work among anxious individuals. Bar-Haim and colleagues (2012), for example, compared high versus low trait-anxiety groups and operationalized their performance as estimation of angry faces relative to neutral faces. The use of angry faces potentially introduces a second variable with which arousal is being manipulated. Jusyte and colleagues (2014) tested a diagnosed social anxiety group against a group with very low trait social anxiety and similarly based performance on angry faces relative to neutral faces. Studies examining the relationship between anxiety and time perception with respect to social threat have briefly discussed the role of attention in overestimation but have been largely dismissive of it as a causal mechanism for overestimation and instead postulate that overestimation is more strongly related to arousal when individuals are anxiety prone (Bar-Haim et al., 2010; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). It may be that when arousal is predominantly manipulated, such as it was in prior studies, the overestimation effect takes precedence. Conversely, predominantly manipulating attention such that resources are devoted away from timing should result in underestimation.

Because the attention mechanism, as it relates to anxiety and timing, is not thoroughly understood, other moderators of attention should be not be neglected from further study (Cisler & Koster, 2010). For example, attentional control, or the ability to focus attention on the task at hand, is theorized to be impaired by anxiety, and this reduced attentional control relates to an attentional bias toward threatening stimuli and difficulty with disengagement from threat. Individuals who are higher on trait anxiety do not automatically demonstrate poor attentional control, suggesting that anxiety and attentional control are independent constructs (Derryberry & Reed, 2002). Individuals who are better at attending to the required task despite their anxiety might perform differently on tasks such as the TBT compared to individuals with either poor attentional control or lower anxiety. An investigation of attentional control mechanisms might provide insight into the fact that, in this study, the AAM group overestimated relative to the NAM group but higher fear of negative evaluation was related to underestimation. If some participants with higher fear of negative evaluation also exhibited poor attentional control, it may be that they were distracted from the TBT and increasingly likely to underestimate.

The more novel part of this study, the TBT at Time 2, yielded mixed results: BFNE, when accounting for change in negative affect between baseline and just after the speech was a significant predictor of underestimation, but change in anxiety over the same time period was not. Furthermore, participants in the NAM group significantly overestimated time relative to their performance before the speech, whereas performance in the AAM group remained the same. As the relationship between BFNE and performance was not consistent across measures of anxiety and negative affect as it was in the TBT at Time 1, replication of this aspect of the study will be key to understanding cognitive mechanisms affecting task performance after the social threat has been completed. Key assignment also emerged as a moderator in significant interactions but its theoretical contribution, further discussed below, was not entirely clear.

Given that the current findings depart from results in previous studies, one major limitation of this study is that alterations in the procedure and the analytic plan, as well as characteristics of the recruited sample makes comparison with the existing literature difficult. First, the interpretation of the results of this study are limited by the indeterminate effect of the anxiety manipulation, which may be related to the consent procedure used. The consent form included a reference to performing a speech at some point during the study and it may be that some participants were alerted to the fact that a speech would occur over the course of the study. This awareness of the future speech may have interfered with proper differentiation of the groups. Although the induction of anticipatory anxiety was designed to mimic previous studies (Davidson, Marshall, Tomarken, & Henriques, 2000), it is unclear whether being alerted to the possibility of having to perform a speech task during the informed consent phase might have influenced participant performance at later parts of the study.

Another characteristic of the sample that limits comparisons to the literature is the variation of traits related to social anxiety present in the sample. Random group assignment resulted in a wider distribution of SPS scores in one group than the other that led to groups needing to be matched on trait anxiety. In the matched sample, results were fairly consistent, whereas in the unmatched sample, there were significant interactions present that were challenging to explain due to their inconsistency. These interactions were suspected to be spurious given that few reached even a trend level of significance in corresponding the matched sample. Results found in the unmatched sample when SPS was the focal predictor were particularly suspect given that the groups were unmatched on the SPS specifically. Furthermore, the presence of potentially clinically anxious individuals in the sample was lower compared to prior studies that had experimental groups comprised entirely of highly trait anxious individuals: only 20% of all participants scored above the cutoff on the SPS that signals likely social anxiety diagnosis (Peters, 2000) and the highest scorers were removed due to the fact that there was a failure of random assignment that resulted in all of the highest scorers being in the NAM group. The relative lack of highly socially anxious participants may have contributed to reduced power to detect the effects of the anxiety manipulation.

As part of data analysis, I accounted for the effect of key assignment. Interestingly, although other studies using the TBT procedure reported counterbalancing key assignment, I am not aware of a study that reports including this variable in ANOVA or regression analyses. Interpreting the results in which key assignment was a predictor of task performance are therefore incomparable other studies, and as a direct result, it is difficult to ascertain the relative importance of findings in which key assignment was a significant predictor. This is particularly true of the interaction between the BFNE, group, and key assignment in the matched data set. An analysis of simple slopes may have revealed the effect on performance was limited to one group and one key assignment condition, but it is still unclear as to whether this finding would inform future investigations. Finally, the current investigation may have been limited by the measures used to explain task performance. Notably, when the effect of group manipulation was entered as into regressions predicting task performance at Time 1, group was significantly predictive of bisection point despite not being significantly related to change in anxiety. This result suggests some impact of group assignment that was not related to change in anxiety alone, but the BSAM and PANAS-NA may not have been sufficient to explain the group effect.

It is important to note that findings do not conflict with the AGM. The theoretical model would predict that increased arousal would result in overestimation and increased attentional resources allocated to timing would result in overestimation. At Time 1, the AAM group was notified about the speech, which might have served to increase arousal enough that, despite the decrease in attentional resources devoted to timing, the end result was still overestimation at the group level, relative to the NAM group. At Time 2, both groups had recently completed the speech task, a task which has been shown to lead to heightened physiological responses (Beidel, Turner, Jacob, & Cooley, 1989), and levels of arousal may not have returned to baseline. Although changes in self-reported anxiety and physiological arousal are related, the relationship is neither proportional nor consistent (Hoehn-Saric & McLeod, 2000). In other words, self-report measures alone cannot be relied upon as a proxy for the changes in physiological arousal that could influence task performance.

The results of the current study hint at the complex interaction between attention and arousal mechanisms as they relate to both induced and trait levels of anxiety. Temporal overestimation occurred following a stressful event as well as preceding it at the group level, but fear of negative evaluation and trait anxiety predicted participants' tendencies to underestimate time. A more thorough understanding of the relative contributions of attention and arousal mechanisms as they relate to anticipation of social threat could potentially yield valuable information about timing mechanisms in general and could also provide a unique avenue through which to quantify the subjective experience of anxious individuals. Because of the gaps in the literature regarding the interplay between anticipatory anxiety, arousal, and attention, future study should prioritize measuring physiological arousal in addition to self-reported anxiety so that the unique contributions of attention and arousal mechanisms to altered perception of time can be further delineated.

References

Angrilli, A., Cherubini, P., Pavese, A., & Mantredini, S. (1997). The influence of affective factors on time perception. *Perception & Psychophysics*, *59*, 972-982. doi:10.3758/BF03205512

Bar-Haim, Y., Kerem, A., Lamy, D., & Zakay, D. (2010). When time slows down: The influence of threat on time perception in anxiety. *Cognition and Emotion*, *24*, 255-263. doi:10.1080/02699930903387603

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*, 1-24. doi:10.1037/0033-2909.133.1.1

Beidel, D. C., Turner, S. M., Jacob, R. G., & Cooley, M. R. (1989). Assessment of social phobia : Reliability of an impromptu speech task. *Journal of Anxiety Disorders*, *3*, 149–158. http://doi.org/10.1016/0887-6185/89

Berg, C. Z., Shapiro, N., Chambless, D. L., & Ahrens, A. H. (1998). Are emotions frightening? II: An analogue study of fear of emotion, interpersonal conflict, and panic onset. *Behaviour Research and Therapy*, *36*, 3-15. doi:10.1016/S0005-7967(97)10027-4

Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, *30*, 203-16. doi:10.1016/j.cpr.2009.11.003

Clark, D. M., & McManus, F. (2002). Information processing in social phobia. *Biological Psychiatry*, *51*, 92-100. doi:10.1016/S0006-3223(01)01296-3

Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social Phobia: Diagnosis, Assessment, and Treatment* (pp. 69-93). New York: Guilford Press.

Davidson, R. J., Marshall, J. R., Tomarken, A. J., & Henriques, J. B. (2000). While a phobic waits: Regional brain electrical and autonomic activity in social phobics during anticipation of public speaking. *Biological Psychiatry*, *47*, 85-95. doi:10.1016/S0006-3223(99)00222-X

Dawson, J. F., & Richter, A. W. (2006). Probing three-way interactions in moderated multiple regression: Development and application of a slope difference test. *Journal of Applied Psychology*, *91*, 917–926. doi: 10.1037/0021-9010.91.4.917

Derryberry, D., & Reed, M. A. (2002). Anxiety-related attentional biases and their regulation by attentional control. *Journal of Abnormal Psychology*, *111*, 225-36. doi:10.1037/0021-843X.111.2.225

Droit-Volet, S., & Meck, W. H. (2007). How emotions colour our perception of time. *Trends in Cognitive Sciences, 11*, 504-13. doi:10.1016/j.tics.2007.09.008

Foa, E. B., Gilboa-Schechtman, E., Amir, N., & Freshman, M. (2000). Memory bias in generalized social phobia. *Journal of Anxiety Disorders*, *14,* 501-519. doi:10.1016/S0887-6185(00)00036-0

Gil, S., & Droit-Volet, S. (2009). Time perception, depression and sadness. *Behavioural Processes*, *80*, 169-176. doi:10.1016/j.beproc.2008.11.012

Gore, K. L., Carter, M. M., & Parker, S. (2002). Predicting anxious response to a social challenge: The predictive utility of the Social Interaction Anxiety Scale and the Social

Phobia Scale in a college population. *Behaviour Research and Therapy*, *40*, 689-700. doi:10.1016/S0005-7967(01)00029-8

Grondin, S. (2010). Timing and time perception: A review of recent behavioral and neuroscience findings and theoretical directions. *Attention, Perception & Psychophysics*, *72* 561-582. doi: 10.3758/APP.72.3.561

Hinrichsen, H., & Clark, D. M. (2003). Anticipatory processing in social anxiety: Two pilot studies. *Journal of Behavior Therapy and Experimental Psychiatry*, *34*, 205-18. doi:10.1016/S0005-7916(03)00050-8

Hoehn-Saric, R., & McLeod, D. R. (2000). Anxiety and arousal: Physiological changes and their perception. *Journal of Affective Disorders*, *61*, 217-24. doi:10.1016/S0165-0327(00)00339-6

Jusyte, A., Schneidt, A., & Schönenberg, M. (2015). Temporal estimation of threatening stimuli in social anxiety disorder: Investigation of the effects of state anxiety and fearfulness. *Journal of Behavior Therapy and Experimental Psychiatry*, *47*, 25-33. doi:10.1016/j.jbtep.2014.11.006

Kopec, C. D., & Brody, C. D. (2010). Human performance on the temporal bisection task. *Brain and Cognition*, *74*, 262-72. doi:10.1016/j.bandc.2010.08.006

Kramer, R. S. S., Weger, U. W., & Sharma, D. (2013). The effect of mindfulness meditation on time perception. *Consciousness and Cognition*, *22*, 846-52. doi:10.1016/j.concog.2013.05.008

Mansell, W., & Clark, D. M. (1999). How do I appear to others? Social anxiety and processing of the observable self. *Behaviour Research and Therapy*, *37*, 419-34. doi:10.1016/S0005-7967(98)00148-X

Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy, 36*, 455-470. doi:10.1016/S0005-7967(97)10031-6

Mills, A. C., Grant, D. M., Lechner, W. V., & Judah, M. R. (2013). Psychometric properties of the Anticipatory Social Behaviours Questionnaire. *Journal of Psychopathology and Behavioral Assessment*, *35,* 346-355. doi:10.1007/s10862-013-9339-4

Peters, L. (2000). Discriminant validity of the Social Phobia and Anxiety Inventory (SPAI), the Social Phobia Scale (SPS) and the Social Interaction Anxiety Scale (SIAS). *Behaviour Research and Therapy*, *38*, 943-950. doi:10.1016/S0005-7967(99)00131-X

Rapee, R. M., & Lim, L. (1992). Discrepancy between self- and observer ratings of performance in social phobics. *Journal of Abnormal Psychology*, *101*, 728-31. doi:10.1037/0021-843X.101.4.728

Rapee, R. M., McCallum, S. L., Melville, L. F., Ravenscroft, H., & Rodney, J. M. (1994). Memory bias in social phobia. *Behaviour Research and Therapy*, *32*, 89-99. doi:10.1016/0005-7967(94)90087-6

Rodebaugh, T. L., Woods, C. M., Thissen, D. M., Heimberg, R. G., Chambless, D. L., & Rapee, R. M. (2004). More information from fewer questions: The factor structure and item properties of the original and Brief Fear of Negative Evaluation scale. *Psychological Assessment*, *16*, 169-181. doi:10.1037/1040-3590.16.2.169

Spielberger, C. D., Gorusch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Tipples, J. (2008). Negative emotionality influences the effects of emotion on time perception. *Emotion (Washington, D.C.)*, *8*, 127-131. doi:10.1037/1528-3542.8.1.127

Watson, D., Clark, L. a, & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070. doi:10.1037/0022-3514.54.6.1063

Zakay, D., & Block, R. A. (1995). An attentional gate model of prospective time estimation. In M. Richelle, V.D. Keyser, G. d'Ydewalle & A. Vandierendonck (Eds.), *Time and the dynamic control of behavior* (pp. 167-178). Liège, Belgium: Universite de Liège.

Table 1

Frequencies and Descriptive Statistics of AAM and NAM Participants

	NAM (n = 43)	**AAM** (n = 40)
Age	19.70 (1.36)	19.23 (1.25)
Female	29 (67.4%)	23 (57.5%)
Race		
Asian	14 (32.5%)	11 (27.5%)
Black	8 (18.6%)	2 (5.0%)
Multiracial	3 (7.0%)	2 (5.0%)
White	18 (41.9%)	24 (60.0%)
Not reported	0	1 (2.5%)
Ethnicity		
Non-Hispanic	41 (95.3%)	36 (90.0%)

Note. Differences between groups were not significant, $ps > .11$. NAM = no anxiety manipulation group; AAM = anxiety manipulation group.

Table 2

Mean Scores on Self-Report Questionnaires

	Unmatched Data			Matched Data	
	NAM	AAM		NAM	AAM
	M (SD)	*M (SD)*		*M (SD)*	*M (SD)*
SPS	20.33(13.2)	14.08 (11.18)	*	17.22(11.75)	14.08(11.18)
ASBQtotal	30.12 (6.22)	29.53 (6.43)		29.22 (6.37)	29.53 (6.43)
ASBQavoid	10.70 (3.14)	10.43 (3.01)		10.22 (3.15)	10.43 (3.01)
ASBQprep	14.21 (2.93)	14.03 (3.16)		13.86 (2.96)	14.03 (3.16)
BFNE	38.29 (9.40)	36.40 (10.51)		21.82 (7.49)	21.90 (8.28)
PANAS-NA	19.55 (6.19)	19.03 (6.69)		18.63 (5.59)	19.03 (6.69)
SAQ	8.98 (4.19)	8.55 (3.81)		9.56 (3.95)	8.55 (3.80)
PSP	24.51 (11.18)	23.98 (8.35)		22.06 (9.28)	23.98 (8.35)

Note. Asterisk (*) denotes significant group difference at $p < .05$. NAM = no anxiety manipulation group; AAM = anxiety manipulation group. SPS = Social Phobia Scale; ASBQtotal = Anticipatory Social Behaviors Questionnaire, all items; ASBQavoid = ASBQ avoidance subscale; ASBQprep = ASBQ preparation subscale; BFNE = Brief Fear of Negative Evaluation, straightforwardly-worded items, PANAS-NA = Positive and Negative Affect Schedule, negative affect subscale; SAQ = Speech Assessment Questionnaire; PSP = Public Speaking Performance Scale.

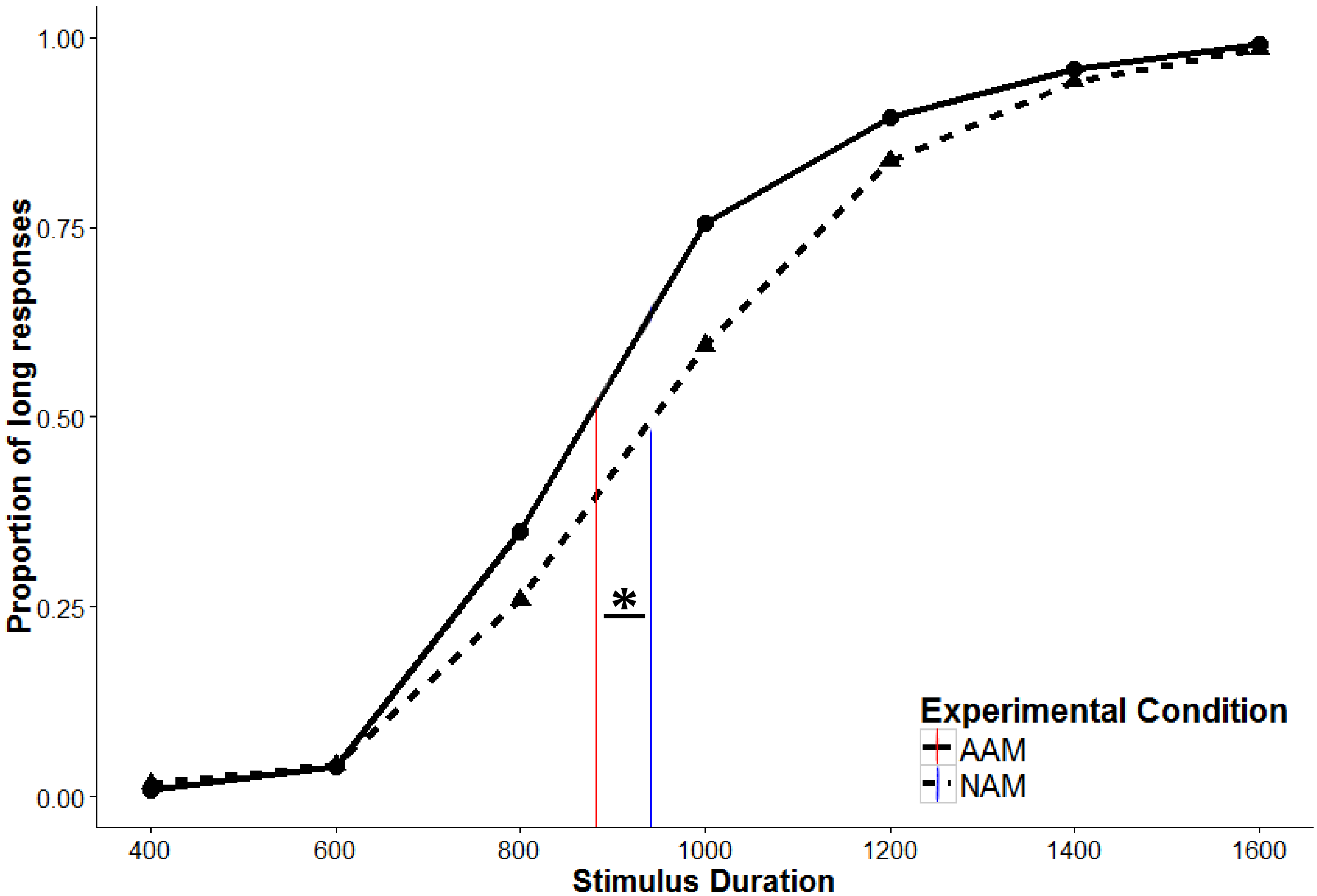

*Figure 1.*Participant proportion of long responses at each stimulus duration on the first temporal bisection task. NAM = no anxiety manipulation group; AAM = anxiety manipulation group. Vertical lines illustrate the mean bisection point for each group (NAM = 940.15 ms; AAM = 881.99 ms).

*p = .002.

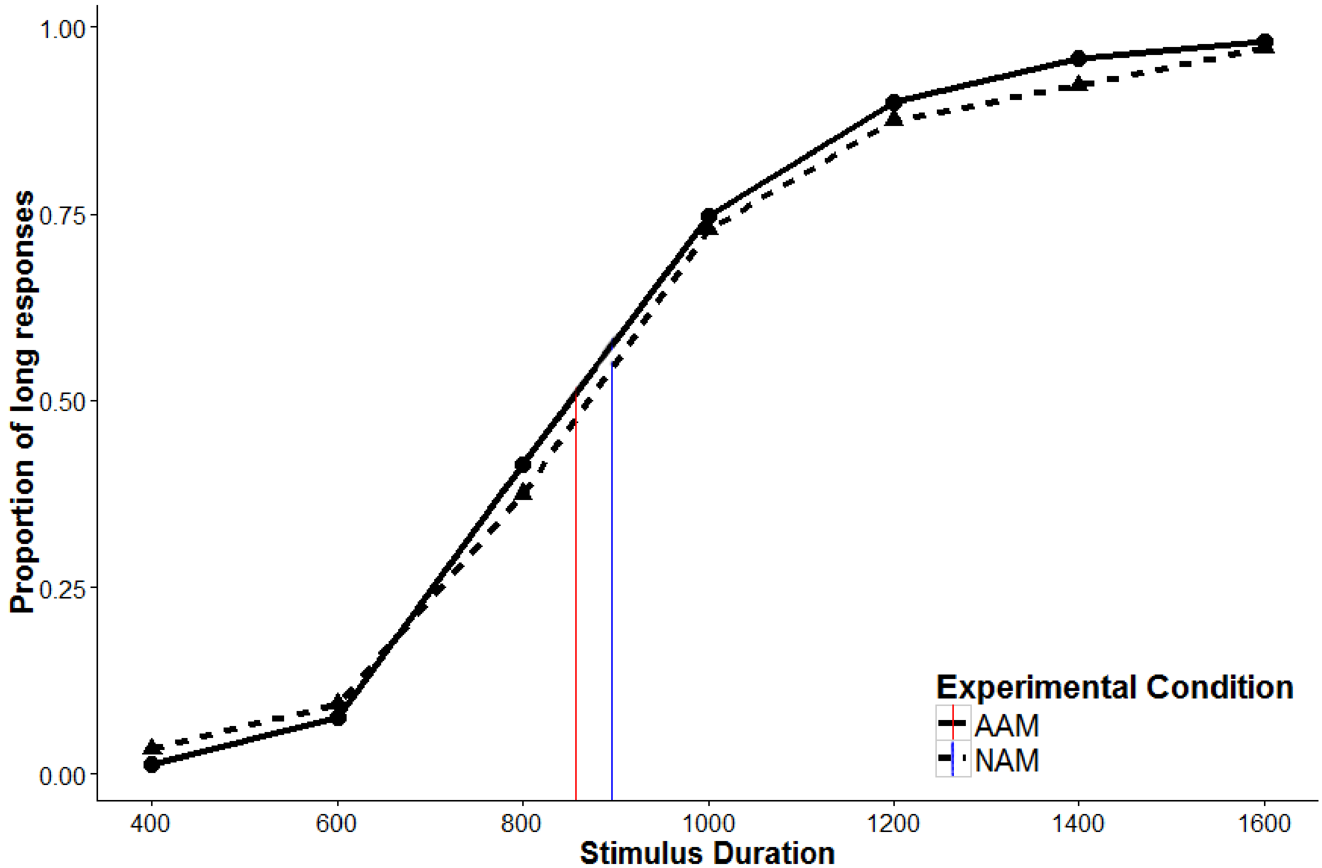

Figure 2. Participant proportion of long responses at each stimulus duration on the second temporal bisection task. NAM = no anxiety manipulation group; AAM = anxiety manipulation group. There were no significant differences between groups. Vertical lines illustrate the mean bisection point for each group (NAM = 896.55 ms; AAM = 856.50 ms).