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Arwen M. Marker April 16, 2012

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Psychology Department

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Abstract

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Near space, or the protective area directly surrounding the body, has been found to correlate with claustrophobic fear (i.e., the fear of enclosed and restrictive situations). Previous research suggests that abnormally large representations of near space may be a causal factor for claustrophobic fear. This study aims to further investigate this relation through active manipulation of the size of near space. Recent research also shows near space to be reliably enlarged through tool use. This study utilizes sticks, specifically, during a line bisection task to enlarge near space representation in a sample of undergraduates. Trait and state-level measures of claustrophobic fear were then taken to analyze the effect of this manipulation on claustrophobic fear. Results suggest that enlarged near spaces may not be a clear causal factor for claustrophobic fear. After the stick manipulation, higher levels of claustrophobic fear were actually found to correlate with smaller near space representations. One possible explanation for these findings may be that individuals with higher levels of claustrophobic fear may exhibit less flexibility in their representations of near space. These inflexible spatial representations, in individuals with high claustrophobic fear could, instead, be a causal factor for this kind of fear.

Keywords: Spatial representation, near/peripersonal space, claustrophobia

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Acknowledgements

A special thank you to Dr. Stella Lourenco for overseeing and advising this project, to Edmund Fernandez for assisting with many aspects of the project and answering all of my many questions, to all of the research assistants who helped run participants and measure lines, and to everyone else in the Spatial Cognition Lab at Emory University for all of their help and support!

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Introduction

Previous research has established a relation between claustrophobic fear and how individuals represent space. People with larger representations of near space (also known as personal or peripersonal space) exhibit higher scores on trait-level measures of claustrophobic fear, that is, anxiety associated with enclosed spaces and physically restrictive situations (Lourenco, Longo, & Pathman, 2011). Near space representation varies between individuals and, even within individuals, can vary flexibly based on context (Graziano & Cooke, 2006; Longo & Lourenco, 2007). Such spatial representations have been shown to respond reliably to some contexts: they can be enlarged through tool use (Berti & Frassinetti, 2000; Gamberini, Seraglia, & Priftis, 2008; Longo & Lourenco, 2006; Serino, Bassolino, Farne, & Ladavas, 2007) or contracted with wrist weights (Lourenco & Longo, 2009). In this study, near space is artificially enlarged through tool use, and the subsequent effects on trait and state-level claustrophobic fear are measured, to determine the extent to which spatial representations play a causal role in the manifestation of claustrophobic fear. More specifically, we investigate whether enlarging representations of near space elicits greater claustrophobic fear, which would suggest a causal relation between individual differences in spatial representation and claustrophobic fear.

Claustrophobia. Claustrophobia is defined as the fear of enclosed spaces or, more broadly, of physically restrictive situations (Rachman, 1997; Radomsky, Rachman, Thordarson, McIsaac, & Teachman, 2001). This phobia is divided on the basis of two contributing factors: the fear of suffocation and the fear of restriction (Rachman & Taylor, 1993; Rachman, 1997; Radomsky et al, 2001). As a phobia, it is an abnormal and irrational fear that hinders everyday functioning. A documented 2-5% of the population suffers from a severe, debilitating form of this phobia. Many more suffer from a less extreme form or are not included in this statistic because they have not sought treatment (Rachman, 1997).

This fear is thought to have evolved in humans and other animals as an adaptive means to realize the dangerous and potentially deadly effects of being trapped and unable to escape. Its current manifestation could be considered a vestige of this fear left over from our evolutionary ancestors (Rachman, 1997; Rachman & Taylor, 1993; Radomsky et al, 2001; Thorpe, Salkovskis, & Dittner, 2008). This vestigial fear can be found to some degree in most individuals (Radomsky et al, 2001). For instance, compared to the general population incidence of about 5%, 15% of patients undergoing MRI scans report severe claustrophobic reactions and 13% experience a full panic attack during the procedure (Thorpe, Salkovskis, & Dittner, 2008), showing that claustrophobic fear can be induced even in non-claustrophobic individuals. These individual differences (at least in our culture) allow us to examine claustrophobic fear in a typical undergraduate sample in the present study, rather than a severely phobic population.

As with other types of fears, claustrophobic fear can reflect long-term (i.e., "trait") and/or immediate (i.e., "state") responses to individual experiences. Trait-level fear describes the characteristic claustrophobic fear level for an individual. It is not tied to the current state or context, but lasts beyond situations as a defining attribute of the individual. State-level fear, in contrast, measures the level of claustrophobic fear in, or immediately following, specific fear-inducing situations (Rachman & Taylor, 1993). Both types of responses were included in the present study to gain a better understanding of claustrophobic fear in specific situations, as well as in an individual's general life. Trait-level fear was measured with the Claustrophobia Questionnaire (CLQ) (Rachman & Taylor, 1993; Radomsky, Rachman, Thordarson, McIsaac, & Teachman, 2001) and state-level fear was calculated with several behavioral tasks (Rachman

& Taylor, 1993). Measures of trait-level fear should associate with state-level measures by correlating specifically with the suffocation and restriction subscales of the CLQ. We included two state-level tasks that have been shown to correlate with the restriction component of claustrophobia and two that have been shown to correlate with the suffocation component (Rachman & Taylor, 1993). These tasks will be described in detail in the Methods section.

There are a number of theories that have been advocated to explain how normal fears can become an irrational phobia, like claustrophobia, in some individuals. A common explanation for the onset of claustrophobic fear is aversive conditioning through a traumatic event. About two-thirds of claustrophobics trace their fear back to a traumatic conditioning experience, such as being trapped in a well as a young child (Ost, 1985; Rachman, 1997). Individuals can develop this phobia after only one aversive experience or even after indirect experiences. This is shown by some evidence which suggests that claustrophobia can emerge following one negative experience in an MRI scanner (Thorpe, Salkovskis, & Dittner, 2008). Other evidence suggests that claustrophobia can emerge vicariously by hearing about or witnessing a traumatic event in another person (Rachman, 1997).

Some claustrophobics, however, never experience an aversive event, or do not develop the phobia even after a traumatic event, suggesting that another cause may be genetic. For instance, 13% of claustrophobics cannot recall a reason for the onset of their phobia (Ost, 1985; Rachman, 1997). Since claustrophobia is easily acquired from exposure to only one experience or indirect exposure, it has been considered a “prepared phobia” that certain individuals may be innately predisposed to develop (Rachman, 1997; Radomsky et al, 2001). Evidence for a genetic predisposition includes the relatively early onset and easy acquisition of claustrophobia. Onset normally occurs between early adolescence and early adulthood, with 37% of the claustrophobic population developing it by age fourteen (Rachman, 1997). The average age of onset is 20 years (Ost, 1987). This early onset "raises the possibility of innate determination," since it is normally acquired early in life, not evenly distributed across the lifespan (Rachman, 1997). As mentioned earlier, researchers believe claustrophobia to be a vestigial fear our ancestors developed for its survival value, which could also be consistent with a genetic basis.

Life stressors, coupled with either of the factors listed above, can further increase the likelihood of developing claustrophobic fear. Recent research reveals a disproportionate acquisition of claustrophobia in old age. In a study of people aged 65 and older in Turkey, 11.5% of the population was found to have specific phobias, including claustrophobia (Kirmizioglu, Dogan, Kugu, & Akyuz, 2009). In fact, specific phobias were found to be the most common psychiatric disorder in the elderly behind cognitive disorders like dementia (Kirmizioglu et al, 2009). This increased likelihood of developing anxiety disorders later in life is probably due to an increase in stressful problems the elderly experience, such as "social isolation, lessening autonomy, economic difficulties, health problems, and awareness of death" (Kirmizioglu et al, 2009), and provides evidence that stress is a factor for the emergence of claustrophobic fear.

In addition, many people with claustrophobia cannot describe what they fear will happen to them in an enclosed space, suggesting the basis for their phobia is unknown (at least explicitly to them) (Radomsky et al, 2001). The fact that people cannot account for the source of their fear could imply that they are experiencing more generalized anxiety in these situations. This is supported by a high rate of comorbidity that exists between claustrophobia and a number of other anxiety disorders, such as acrophobia (fear of heights) and agoraphobia (fear of social situations) (Thorpe et al, 2008).

A final theory for the development of claustrophobic fear could be found in individual differences in spatial representation. The feelings of panic claustrophobics experience in enclosed spaces could be caused by a "misinterpretation of bodily sensations," when physiological feelings of fear cause cognitive feelings of panic (Rachman, 1997; Thorpe et al, 2008). The "catastrophic interpretations of this fear and the bodily sensations that go along with it" could be driven by cognitive beliefs, which are impacted by differences in how individuals represent space (Thorpe et al, 2008). Researchers have suggested that people who experience high claustrophobic fear might represent the space between themselves and an enclosure (e.g., an elevator) as smaller than people who are low in claustrophobic fear (Lourenco et al, 2011). Claustrophobics might then panic in this situation, which most people would not find uncomfortable, because they perceive these spaces differently than non-claustrophobic individuals.

Conversely, representations of space could be distorted by the fear associated with certain, potentially dangerous, situations. In previous research, estimations of height and steepness were influenced by the fear individuals experienced in these situations (Stefanucci & Proffitt, 2009; Stefanucci, Proffitt, Clore, & Parekh, 2008). When standing on a balcony looking down, participants overestimated the distance to the ground more than when standing on the ground looking up (Steffanucci & Proffitt, 2009). This could be because the former is more fear-inducing, resulting in an altered representation of the same space. When standing at the top of a hill, participants estimated the hill to be steeper when standing on top of a skateboard, and less steep when standing on a wooden box of the same height (Stefanucci et al, 2008). Again, in fear-inducing (or unsafe) situations, spatial representations were altered by the perceived danger. This shows spatial representation to be a possible reciprocal factor in the experience of claustrophobic fear. Taken together, there are reasons to believe that there is a link between spatial representations and claustrophobic fear; unclear, however, is the causal direction – that is, distortions in spatial representation could cause fear, or exaggerated fear could induce changes in spatial representation.

Near Space. Near space, or peripersonal space, is the area immediately surrounding the body that serves as a protective buffer against approaching, potentially harmful, objects (Berti & Frassinetti, 2000; Gamberini et al, 2008; Longo & Lourenco, 2006, 2007; Lourenco, Longo, & Pathman, 2011). This area acts as a "margin of safety around the body [for the] selection and coordination of defensive behaviors" (Graziano & Cooke, 2006). It is also the area for action against approaching stimuli, distinguishing it from the space farther away. The area outside an individual's near space is referred to as far, or extrapersonal, space (Berti & Frassinetti, 2000; Gamberini et al, 2008; Longo & Lourenco, 2006, 2007; Lourenco et al, 2011). Far space is another area in which objects can be perceived, but no immediate action-coordination is contingent upon them and protection of the body is not crucial, because objects at these far distances are not as personally threatening.

Near space representation varies between individuals and shows some flexibility within individuals. Near space is often referred to as the space within arm's reach (Berti & Frassinetti, 2000; Longo & Lourenco, 2006, 2007), and thus is correlated with body size, specifically arm length. It has been shown that taller individuals with longer arms have larger near space representations than individuals with shorter arms (Longo & Lourenco, 2007; Lourenco et al, 2011) – at least when near space is measured using a line bisection task. Size of near space can also show some flexibility dependent on context. "A person who is placed in a potentially threatening context will have an expanded personal space; a person in friendly company will have a reduced personal space" (Graziano & Cooke, 2006). Conversely, near space representations that are based on body size and other intrinsic factors could alter the perceived threat or safety in specific contexts. This variation implies that the size of near space and attention to objects within this area are closely linked. However, when context remains the same, near space representation remains constant over time. This is shown by size of near space remaining consistent when re-measured on separate days (Longo & Lourenco, 2007).

Previous research shows that an individual's near space can be enlarged by active tool use (Gamberini, Seraglia, & Priftis, 2008; Longo & Lourenco, 2006, 2007; Lourenco & Longo, 2009; Lourenco et al, 2011; Serino, Bassolino, Farne, & Ladavas, 2007). This enlargement occurs because tools artificially lengthen the arm and near space representation expands to include this additional length (Berti & Frassinetti, 2000; Longo & Lourenco, 2006). This enlargement has also been replicated in virtual reality (Gamberini et al, 2008) and with blind individuals who use canes (Serino et al, 2007). Near space can also be contracted by wrist weights (Lourenco & Longo, 2009). This is thought to occur because "weighting the arm…alters its perceived length" (Lourenco & Longo, 2009). The weights produce a feeling of restriction so the arms are perceived as unable to reach as far, with the size of near space shrinking accordingly.

In these studies investigating enlargement and contraction of near space, changes in spatial representations were measured with a line bisection task. This task utilizes knowledge of hemispheric lateralization to measure biases in how individuals direct attention. The brain's hemispheres direct attention contralaterally, meaning that the left hemisphere directs attention to the right, and the right hemisphere directs attention to the left. Normally, the left hemisphere produces a stronger "pull" so that overall attention is biased towards the right. However, in near space, the opposite effect occurs. Typical individuals exhibit a slight leftward attentional bias in near space, known as pseudoneglect (Longo & Lourenco, 2007). This is due to the left hemisphere directing attention more dominantly in far space, while the right parietal lobe is thought to direct attention in near space (Berti & Frassinetti, 2000; Graziano & Cooke, 2006; Longo & Lourenco, 2006, 2007). In previous research, this difference is apparent as bias on a line bisection task shifts rightward with increasing distance (Longo & Lourenco, 2006, 2007; Gamberini et al, 2008).

Similar to individuals whose near space has been enlarged with tool use, individuals with high levels of claustrophobic fear have been shown to exhibit greater pseudoneglect and a more gradual rightward shift with increasing distance (Lourenco, Longo, & Pathman, 2011). These findings are shown in previous correlational research with the line bisection task:

> "Independent of arm length, participants with greater claustrophobic fear showed more gradual rightward shifts in attentional bias over distance than those with less claustrophobic fear. This suggests that people with greater anxiety of enclosed spaces and physically restrictive situations represent near space as larger than those with less of such anxiety" (Lourenco et al, 2011).

A possible explanation for this relation is that objects or surroundings encroaching on one's protective buffer (i.e., near space) may be cause for fear and anxiety (Graziano & Cooke, 2006; Lourenco et al, 2011). Individuals feel anxious when things encroach on this protective area because there may not be enough time to coordinate defensive behaviors against these objects, if necessary (Graziano & Cooke, 2006).

Previous research suggests two possible explanations for the correlation between the size of near space and trait-level claustrophobic fear: 1) Naturally larger near spaces lead to higher levels of claustrophobic fear. When parts of the external environment infringe on near space, it induces anxiety. Individuals with enlarged near spaces experience this anxiety when "infringing" objects are farther away, at a distance typical individuals would not find uncomfortable. Or 2) The onset of claustrophobic fear leads to an enlargement of near space representation as a protective consequence. In other words, fear induces an enlarged representation of near space, possibly as a defensive mechanism.

Present Study. In the current experiments, the possibility that an enlarged near space causes increased levels of claustrophobic fear was investigated. It is unclear whether claustrophobic fear results from "an underlying distortion in the representation of near space" or whether fear is the factor causing this spatial distortion (Lourenco et at, 2011). Previous results were correlational, so in this study, near space representation was actively manipulated through tool use, and the subsequent effects on claustrophobic fear measured, to ascribe causation.

These effects on claustrophobic fear were measured in two ways, resulting in two separate experiments. In the first experiment, trait-level claustrophobic fear was measured using the Claustrophobia Questionnaire (CLQ). Trait-level fear was measured after near space was artificially enlarged to observe alterations in participants' characteristic fear levels. Trait-level fear is relatively stable over time and generally more resistant to change than state-level fear (Rachman & Taylor, 1993), thus increases in CLQ scores following tool use would provide dramatic evidence for atypical near space representations being a causal factor for claustrophobic fear. In the second experiment, state-level claustrophobic fear was measured, in addition to the CLQ. State-level fear is the amount of fear an individual experiences in a specific situation, or state. Such fear is more malleable and likely to change based on the context (Rachman & Taylor, 1993). State-level fear was measured to obtain a more accurate account of fear changes in specific situations where near space has been enlarged. This was done by exposing participants to claustrophobic situations, including wearing a gas mask, breathing through a straw, lying on a bottom bunk bed, and wearing a bag meant to simulate the experience of a strait-jacket. Both kinds of measures (trait and state) were given to examine how broadly near space enlargement might affect claustrophobic fear and to obtain clearly distinguishable accounts of the effects on trait and state levels of claustrophobic fear. We predicted that trait level fear might be more inflexible and resistant to change, whereas state level fear might vary more flexibly with tool use and situational changes.

We predicted that if size of near space is responsible for particular levels of claustrophobic fear, we should see differences in fear levels between participants in the different line bisection conditions. In both experiments, we predicted tool use would artificially enlarge near space and cause higher levels of claustrophobic fear, thus providing evidence that a distorted representation of near space is one of the causal factors of such fear. We also predicted that these results would be especially apparent at the state-level, since this type of fear may be more malleable and receptive to change.

Experiment 1

Experiment 1 utilized a between-subjects design to investigate the causal relation between near space representation and trait-level claustrophobic fear in a population of non-phobic undergraduate students. Participants were assigned to either the experimental (stick) group, which used sticks throughout the study meant to expand near space, or the control (laser) group, which did not use sticks. A line bisection task was used to measure near space representation for both groups. The experimental group completed this task using sticks (which should expand near space representation), whereas the control group used a laser pointer (which does not alter near space representation) (Bassolino, Serino, Ubaldi, & Ladavas, 2010). After the line bisection manipulation, all participants completed the Claustrophobia Questionnaire (CLQ) to assess trait-level claustrophobic fear. Additionally, all participants answered the Agoraphobia Cognitions Questionnaire (ACQ) and Acrophobia Questionnaire (AQ) to assess general anxiety levels. All questionnaires were completed with paper and pen.

Method

Participants

Thirty-six Emory undergraduates participated in this study (27 female; $M_{age} = 19.29$, $SD = .923$). Participants were recruited from introductory psychology courses and were randomly assigned to either the experimental or control groups, resulting in 18 participants in each group. Handedness information was also collected for all participants using the Edinburgh Handedness Inventory (EHI) (*Range*: -72.73 to 100; $M = 79.99$) (Oldfield, 1971). All participants had normal or corrected-to-normal vision.[1]

Measures

A number of different measures were used in this experiment. Near space representation was measured using a line bisection task. Trait-level claustrophobic fear was measured with the Claustrophobia Questionnaire (CLQ). Measures of general anxiety were collected using the Agoraphobia Cognitions Questionnaire (ACQ) and the Acrophobia Questionnaire (AQ). Each of these measures are described below.

Line Bisection Task: This task is used to measure the "size" of each participant's near space. This task is based on previous research by Longo and Lourenco (2006) and Lourenco, Longo, and Pathman (2011). In social psychology and cross-cultural research, the typical way to measure near space is through "approach" tasks, in which a participant tells an experimenter to stop approaching before he or she reaches an uncomfortably close distance. This can also be measured by the participant approaching the experimenter and stopping at a comfortable distance. However, this method was not used in this study because it can be highly subjective, influenced by gender variables and cultural biases (Brown, 1973; Young & Guile, 1987). Instead, the line bisection task measures near space using spatial-attentional biases less affected by these subjective factors. It is known that when in near space, individuals exhibit a slight leftward attentional bias known as pseudoneglect (Longo & Lourenco, 2006). Processing of near space occurs preferentially in the right parietal lobe, biasing attention contralaterally to the left. As lines are moved outside of near space, there are rightward shifts in bias because the left hemisphere is stronger at directing attention in far space (Longo & Lourenco, 2007). Using the line bisection task, a shift from left (in near space) to right (in far space) can be observed. The rate at which this shift occurs provides an accurate measure of the size of an individual's near space (Lourenco et al, 2011). Additionally, this measure of near space has been found to be consistent for individuals over time if un-manipulated, as shown by high test-retest reliability ($r = .81$, $p < .0001$) (Longo & Lourenco, 2007).

Each participant received a total of 72 lines, either 10, 20, or 30 cm in length and all 1 mm wide. These lines were centered on legal-sized paper and attached to the wall, 56 cm above the ground. Participants stood 30, 60, 90, and 120 cm from the wall during the bisection task. Lines of each length were distributed equally across each distance. All of the lines were measured by at least two coders, with a maximum of .25 mm disagreement between coders. This measurement determined deviations from center, providing a precise measure of bisection bias. All line measurements at each distance were then averaged to generate the participant's average bisection bias at each distance.

Questionnaires: To measure trait-level claustrophobic fear, we used the CLQ, originally developed by Rachman and Taylor (1993). The short version of this questionnaire, which contains only the most valid and reliable 26 questions, was the actual form used in the present study (Radomsky et al, 2001). This questionnaire contains two subscales, one measuring suffocation (SS) and one measuring restriction (RS). The SS subscale contains 14 items and the RS subscale contains 12 items, each of which were answered using a Likert scale (0 = "not at all anxious" and 4 = "extremely anxious"). For example, participants were asked, how anxious would you feel in the following places or situations:

Working under a sink for 15 minutes (SS).

At the furthest point from an exit on a tour of an underground mine shaft (SS).

Locked in a small dark room without windows for 15 minutes (RS).

Handcuffed for 15 minutes (RS).

This questionnaire demonstrates good psychometric properties for a sample of non-phobic undergraduate students, in addition to reliably discriminating between claustrophobic and non-claustrophobic individuals. Based on previous research, means for a claustrophobic group were significantly higher than means for a non-phobic group for the entire questionnaire ($t = 7.42$, $p < .001$), as well as for the SS ($t = 6.28$, $p < .001$) and RS ($t = 2.68$, $p < .01$) subscales (Radomsky et al, 2001). This measure also contains high internal consistency, as measured by Cronbach's α for the entire CLQ ($\alpha = .95$), the SS subscale ($\alpha = .85$), and the RS subscale ($\alpha = .96$). The CLQ exhibits high test-retest reliability as demonstrated by high Pearson's r correlations ($r_{overall\ CLQ} = .98$, $r_{SS} = .89$, $r_{RS} = .77$, $p < .001$) (Radomsky et al, 2001).

The Agoraphobia Cognitions Questionnaire (ACQ) and Acrophobia Questionnaire (AQ) were included in this study as contrastive controls to determine the specific relation between near space and claustrophobic fear, not just fear in general. These two measures were chosen because these phobias show high co-morbidity with claustrophobia (Rachman, 1997). The ACQ measures agoraphobia, or fear of public spaces and panic attacks. This instrument contains 14 items concerning the "negative consequences of experiencing anxiety" (Chambless, Caputo, Bright, & Gallagher, 1984). Each item is listed twice and subjects are asked to describe how nervous or frightened they would feel (on a scale from 1 to 5; 1 = "thought never occurs" and 5 = "thought always occurs") and how often they experience symptoms of panic (on a scale from 0 to 100; 0 = "I do not believe this thought at all" and 100 = "I am completely convinced this thought is true") in specific situations (Chambless et al, 1984). Some sample items are:

I am going to throw up.

I am going to pass out.

I am going to babble or talk funny.

This measure demonstrates high test-retest reliability for the entire scale (r = .86), as well as for individual items (M = .74). The ACQ reliably discriminates between agoraphobic and non-agoraphobic individuals, and shows a significant score decrease after treatment (t = 4.08, p < .001) (Chambless et al, 1984).

The AC scale was used to measure acrophobia, or fear of heights. It is a 40-item questionnaire in which 20 items are listed twice. With this measure, subjects were asked to indicate how anxious they would feel in a situation (on a scale from 0 to 6; 0 = "not at all anxious" and 6 = "extremely anxious") and how often they would avoid each situation (0 = "would not avoid doing it", 1 = "would try to avoid doing it" and 2 = "would not do it under any circumstances") (Cohen, 1977). Some sample items include:

Diving off the low board at a swimming pool.

Looking down a circular stairway from several flights up.

Riding a ferris wheel.

This scale moderately correlates with other self-report and behavioral test measures of acrophobia ($r = .43$, $p < .01$) and shows high test-retest reliability ($r = .82$) (Cohen, 1977).

Design and Procedure

This study utilized a between-subjects design to provide the clearest distinction between enlarged near spaces and unaltered near space representation for different individuals. Informed consent was received and all participants answered the EHI. At this time, arm length and height measurements were also taken, since the size of near space has been found to correlate with body size (Longo & Lourenco, 2007).

Participants were randomly assigned to either the experimental (stick) or control (laser) groups, except for some attempts to equate the numbers of males and females in each group. However, it was impossible to fully balance gender in this study given the higher volume of females in the subject pool. The experimental group used sticks in the line bisection task with the goal of enlarging near space representation, while the control group used laser pointers with the goal of measuring typical near space "size" in these individuals.

The experimental group completed the line bisection task using sticks (see Figure 1). The use of sticks manipulated the size of participants' near space by artificially lengthening the arm (Berti & Frassinetti, 2000; Longo & Lourenco, 2006). It has been suggested that the stick works by expanding the range of effective action, or one's reach, so near space is perceived as normal arm length plus the length of the stick, thus enlarging this space. There were four sticks, one corresponding to each distance of 30, 60, 90, and 120 centimeters. These sticks tapered to a point at one end to allow participants to bisect the lines precisely. Participants were instructed to hold each stick in their right hand with their arms in close to their body, not outstretched.

The control group bisected lines using a laser pointer mounted on a tripod (see Figure 1). The laser pointer is a small object that does not extend the participants' arm length and has been shown previously to not expand near space (Bassolino et al, 2010; Berti & Frassinetti, 2000; Gamberini et al, 2008; Longo & Lourenco, 2006, 2007, 2009; Lourenco et al, 2011), so these bisections represent the individual's natural near space representation. The tripod was kept at a constant height of 115 cm and was placed adjacent to the right side of each participant, so that the tip of the laser pointer was even with the front of their body at each of the distances. Participants used their right hand to maneuver the pointer.

Immediately following completion of the line bisection task, all participants answered the CLQ with paper and pen. This measured trait-level claustrophobic fear while the participants were still experiencing an artificially enlarged near space for the stick group, or their typical near space representation for the laser group. At this time, participants also completed the ACQ and AQ as measures of their general fear levels. After this, participants were debriefed as to the real purpose of the study and received class credit for their participation.

Results and Discussion

Line Bisection Analyses. Responses on the line bisection task were calculated by measuring the rightward bisection deviation on each line and averaging all lines at each distance. Using a least-squares linear regression, the average bisection bias at each distance was regressed across all four distances. The resulting slope represents the "absolute bisection bias" for each condition, laser and stick. Each slope was also calculated as a proportion, to control for differences in bisection bias based on line length (since shorter lines allow for less deviations in bisection bias, while longer lines allow for more deviation). The proportion bisection bias was also calculated with a least-squares linear regression, which regressed the proportion of average bisection biases across all four distances. The resulting slope represents the "proportion bisection bias" for each condition.

From previous research, we expected the laser condition to exhibit a larger slope than the stick condition. A steeper slope indicates a smaller near space representation, while a more gradual slope indicates a larger near space. When comparing means of absolute bias, these previous results were replicated in the present study (M_{laser} = 1.014, *SD* = .576; M_{stick} = .465, *SD* = .635). In a one-way ANOVA of between-subjects effects, the bias associated with the laser and stick conditions differed significantly from one another ($F_{absolute}(1,34) = 7.357$, $p = .01$; $F_{proportion}(1,34) = 9.232$, $p = .005$), indicating that the stick manipulation successfully altered near space representation (see Figure 2). Since both the absolute bias and proportion bias showed similar results, the absolute bias is reported in further calculations, except where indicated otherwise. There were also no differences due to sex in this experiment ($p > .10$), so it is not included as a variable in further analyses.

Claustrophobia Questionnaire (CLQ) Analyses. Out of a possible maximum trait-level fear rating of 104 on the CLQ, participant scores ranged from 4-76. When mean claustrophobic fear was analyzed with a one-way ANOVA of between-subjects effects, scores on the CLQ did not differ significantly between the laser and stick conditions ($p > .16$) (see Table 1). Moreover, correlation analyses revealed that CLQ scores in the laser condition did not correlate significantly with absolute or proportion bias ($r(18) = .137$, $p > .50$) (see Figure 3). In the stick condition, however, the suffocation subscale (SS) of the CLQ did correlate significantly with proportion bias ($r_{proportion}(18) = .509$, $p = .031$) (see Figure 4), but the overall CLQ and restriction subscale (RS) did not ($p > .05$ and $p > .10$, respectively). It should be noted, though, that the correlation with the SS subscale was in the opposite direction as expected. Previous research found a negative correlation between CLQ scores and bisection bias, at least when using a laser pointer during line bisection (Lourenco et al, 2011). The positive correlation found here suggests that higher levels of claustrophobic fear were actually associated with steeper slopes, and thus smaller near spaces, at least in the stick condition where we attempted to enlarge participants' near spaces. This is discussed further in the General Discussion.

Analyses of Other Questionnaires. Claustrophobic fear may be co-morbid with other phobias. For this reason we included the Acrophobia Questionnaire (AQ) and the Agoraphobia Cognitions Questionnaire (ACQ) to ensure that any differences between the stick and laser conditions were specific to claustrophobic fear, not general anxiety. Scores from the CLQ correlated significantly with scores from the AQ ($r(36) = .712$, $p = .000$), especially for the stick condition ($r_{stick}(18) = .805$, $p = .0001$), but did not correlate with ACQ scores ($r(36) = -.054$, $p > .70$). When partialled out, neither the AQ nor the ACQ significantly affected the association between the stick manipulation and claustrophobic fear levels.[2]

Experiment 2

Experiment 2 utilized a between-subjects design to investigate the relation between near space representation, state-level, and trait-level claustrophobic fear in a population of non-phobic undergraduates. Participants were divided into experimental (stick) and control (laser) groups and completed the line bisection task, just like in the previous experiment. Again, near space representation was meant to be expanded through stick use in the experimental group and unaltered in the control group. All participants then completed four behavioral tasks meant to assess state-level claustrophobic fear. These tasks placed participants in claustrophobic-fear-inducing situations to assess fear levels in specific situations, which included: breathing through a straw, wearing a gas mask, lying in a bunk-bed-like construction, and wearing a restrictive bag resembling a straight-jacket. Trait-level claustrophobic fear was again assessed with the CLQ. Responses for the behavioral tasks and CLQ were given using sticks, in the experimental group; and participants gave responses with the laser pointer, in the control group.

Method

Participants

Thirty-three Emory undergraduates completed this experiment (21 female; M_{age} = 19.60, *SD* = 1.06). One additional participant did not finish the study due to sickness, and was dropped from the analyses. Participants in this experiment were also recruited from the subject pool of introductory psychology courses and randomly assigned to the experimental (stick) or control (laser) condition. This resulted in sixteen participants in the stick condition and seventeen participants in the laser condition. EHI scores ranged from -33.33 to 100 (*M* = 73.88). All participants reported normal or corrected-to-normal vision.[3]

Measures

The same measures were used as in the previous experiment, with the exclusion of the AQ and ACQ questionnaires. In addition, four behavioral tasks designed to elicit claustrophobic fear were included. These tasks were replicated from previous research and were included to measure state-level claustrophobic fear (Rachman & Taylor, 1993).

Behavioral Tasks: In these tasks, participants were asked to 1) breathe through a narrow straw, 2) wear a gas mask, 3) lie in a bunk-bed-like construction, and 4) wear a bag with ties encircling their body, resembling a straight-jacket (see Figure 5). For each task, the situation was fully described to the participant, who then predicted how fearful they would feel during the task (on a scale from 0 to 100; 0 = “no fear” and 100 = “extreme fear”). The participant then engaged in each task for a full two minutes, reporting the actual amount of fear they experienced during the task with the same scale.[4] This procedure was repeated for all four tasks.

Measures of claustrophobic fear using the straw and gas mask have been found to correlate with the suffocation subscale (SS) of the CLQ. Correlations with SS were ($r_{predicted}$ = .80, $p < .001$) and ($r_{reported}$ = .60, $p < .001$) for the straw, and ($r_{predicted}$ = .51, $p < .001$) and ($r_{reported}$ = .41, $P < .001$) for the gas mask. The bag and bunk bed tasks were previously found to correlate strongly with the restriction subscale (RS) of the CLQ, with correlations of ($r_{predicted}$ = .77, $p < .001$) and ($r_{reported}$ = .85, $p < .001$) for the bed and correlations of ($r_{predicted}$ = .64, $p < .001$) and ($r_{reported}$ = .47, $p < .001$) for the bag (Rachman & Taylor, 1993). Rachman and Taylor also included a fifth task of spending two minutes in a small dark closet. This task was excluded from the current study because a suitable location was unavailable.

Design and Procedure

This study utilized the same design and a similar procedure as in Experiment 1. All participants gave written consent, completed the EHI, and had measurements taken for arm length and height. They then completed the line bisection task, either with sticks (experimental group) or the laser pointer (control group). Immediately after this, participants completed the behavioral tasks and the CLQ. These were counterbalanced so some participants received the behavioral tasks first and others received the questionnaire first. The behavioral tasks were also counterbalanced such that each task was completed first at least eight times (except for the mask condition, which was completed first nine times). The order of subsequent behavioral tasks was randomized.

To prevent effects of the stick manipulation from wearing off during these tasks, participants in the stick group described their predicted and reported fear levels using the longest stick and standing at the furthest line bisection distance (120 cm). Participants used the stick to point to the number corresponding to their fear level on a paper, with numbers 0-100, affixed to the wall. Participants in the laser group also stood at the 120 cm distance and used the laser pointer to indicate their fear levels by pointing to the same paper scale. The CLQ was administered using this same method. Participants answered the questionnaire while standing at 120 cm and using the stick or laser pointer to indicate their responses. The experimenter read the questions and the participant gave responses by pointing to the number corresponding to their level of anxiety (0 to 4; 0 = "not at all anxious" and 4 = "extremely anxious"). To prevent response bias, all answers were recorded by a video camera while the experimenter faced the opposite direction. The videos contained only the subject number and were coded at a later time. The additional time taken to complete the behavioral tasks prompted the removal of the ACQ and AQ questionnaires from this second experiment. Finally, participants were debriefed and received class credit for their participation.

Results and Discussion

Line Bisection Analyses. In Experiment 2, absolute and proportion bisection bias were computed using the same procedure as Experiment 1. In a one-way ANOVA of between-subjects effects, the bisection bias did not differ significantly across the laser and stick conditions ($F_{absolute}(1,31) = .000$, $p > .90$; $F_{proportion}(1,31) = .702$, $p > .40$) (see Figure 6). This suggests the line bisection task did not work as planned. In a comparison of mean bisection bias, absolute bias was very small in both conditions, possibly suggesting larger near spaces for individuals tested in this experiment (M_{laser} = .3155, *SD* = .465; M_{stick} = .3147, *SD* = .528). The means of bisection bias were comparable across the two experiments for the stick condition, but bisection bias slopes for the laser condition in Experiment 2 were significantly smaller than bias for the laser condition in Experiment 1 ($F(1,32) = 14.866$, $p = .001$). This suggests that the stick manipulation may have worked to expand near space but that participants had similarly large near spaces in the laser condition. What might account for this unexpected finding? One possibility is that participants in the laser condition could happen to be a sampling of individuals with naturally larger near spaces. Previous research has found associations between bisection bias and body size, as measured by arm length (Longo & Lourenco, 2007; Lourenco et al, 2011). In this study, body size correlated with bisection bias (but only as measured by height without shoes), but there were no significant differences for any of the body size measures between conditions (as measured by height, wingspan, or right arm length) (all *ps* > .15). It thus remains unclear what might account for the smaller slopes, and thus larger near spaces, in the laser condition of this experiment. There were also no differences due to sex across the two conditions ($p > .20$).

CLQ Analyses. Even though the two line bisection conditions did not appear different based on comparisons of bisection bias, there were differences between the groups. Out of the maximum possible score of 104 points on the CLQ, participants in this experiment reported scores ranging from 2-73. When trait level fear was analyzed in a one-way ANOVA of between-subjects effects, CLQ scores were approaching a significant difference across conditions ($F_{CLQ}(1,31) = 3.872$, $p = .058$) (see Table 2). In correlation analyses of the laser condition, a significant negative correlation was found between bisection bias and the SS subscale of the CLQ ($r(16) = -.565$, $p = .023$) (see Figure 7), replicating previous findings that higher levels of claustrophobic fear are associated with smaller slopes of bisection bias, and thus larger near spaces (Lourenco et al, 2011). Correlation analyses, however, revealed no significant correlations with the RS subscale in the laser condition ($p > .90$). In the stick condition, positive correlations between bisection bias and CLQ scores were seen again, as in Experiment 1. Slopes for the stick condition were significantly correlated with overall CLQ scores and the RS subscale ($r_{CLQ}(17) = .554$, $p = .021$; $r_{RS}(17) = .578$, $p = .015$) (See Figure 8), but not with the SS subscale ($r_{SS}(17) = .455$, $p > .06$). This suggests that in the stick condition higher levels of claustrophobic fear were associated with smaller, not larger, near space representations. Although this correlation is contrary to the expected direction, it replicates the finding in Experiment 1. That is, when participants used sticks during the line bisection task (meant to increase the size of near space), they actually reported less, not more, trait-level claustrophobic fear. See the General Discussion for further explanation of these results.

Analyses of State-Level Claustrophobic Fear. In addition to the CLQ, participants in Experiment 2 were given a battery of behavioral tasks to measure state-level claustrophobic fear. For each task, predicted scores were recorded after each task was explained, but before starting the task, and reported scores were recorded after the task had been attempted for two minutes. Out of a possible maximum fear rating of 100, scores ranged from 0-95 on the behavioral tasks. Across all tasks, predicted scores were generally higher than reported scores ($M_{predicted} = 13.507$, $SD = 17.53$; $M_{reported} = 10.749$, $SD = 15.29$). This suggests that the thought of these tasks was more frightening than the actual experience for the non-phobic sample tested. Scores were also generally higher in the stick condition (except for $\text{mask}_{\text{reported}}$ and $\text{bag}_{\text{reported}}$ scores), but when tested in an ANOVA of between-subjects effects, none of the behavioral task mean scores differed significantly between the stick and laser conditions (all *ps* > .20) (see Table 3). In a correlation analyses, a positive correlation was found between bisection bias and the mask behavioral task for the stick condition ($r_{predicted}(17) = .606$, $p = .010$; $r_{reported}(17) = .553$, $p = .021$) (see Figure 9). Like the associations between CLQ score and bisection bias in the stick condition, these correlations were in the opposite direction than expected. A positive correlation denotes that smaller bisection bias slopes, and thus larger near spaces, were associated with lower levels of claustrophobic fear.

Further correlation analyses revealed that the behavioral tasks also correlated strongly with the CLQ, especially with the SS subscale (with the exception of the predicted bag score) (see Table 4). It was surprising there was not a more noticeable split between the RS and SS subscales and their correlations with the behavioral tasks, as suggested by Rachman and Taylor (1993). It was expected that the bed and bag tasks would correlate strongly with the RS subscale, but instead they correlated strongly with the SS subscale. The straw and mask tasks also correlated with the SS subscale as expected. This may imply that the SS subscale was a more sensitive measure in the present study.

General Discussion

In Experiment 1, the stick manipulation appears to have successfully expanded near space representation in the experimental (stick) group. The stick group displayed less of a rightward shift with increasing distance and maintained an overall leftward bias at all distances, which is consistent with previous research that tool use expands near space representation (Berti & Frassinetti, 2000; Gamberini et al, 2008; Longo & Lourenco, 2006; Serino et al, 2007). Overall slope of bisection bias differed between groups, with near space representation in the stick condition being significantly larger than non-expanded near space in the laser condition.

Even though the experimental manipulation appears to have worked, trait claustrophobic fear (as measured by the CLQ) did not differ significantly between groups, as analyzed with a one-way ANOVA, in either experiment. This suggests that claustrophobic fear may not be easily altered by changes in spatial representation, as hypothesized. However, correlation analyses revealed some significant effects. In the laser condition in Experiment 2, bisection bias correlated with scores on the SS subscale of the CLQ, showing a relation between near space representation and claustrophobic fear. This replicates previous research (Lourenco et al, 2011). In Experiment 2 and Lourenco et al., significant negative correlations were found between slope bias and CLQ scores. Smaller slopes of bisection bias represent larger near spaces, so a negative correlation indicates that larger near spaces were associated with higher levels of claustrophobic fear. However, in Experiment 1, this negative correlation was not replicated. The absence of these findings in Experiment 1 could be due to a power issue, with the sample size being too small to overpower individual variability. The findings from the previous Lourenco et al. study had almost twice as many participants in the laser condition alone, allowing for a larger, more representative sample. A larger sample size could improve the likelihood of finding associations between slope bias and CLQ scores in Experiment 1 and increase correlations with the RS subscale to levels of significance in Experiment 2. Due to time constraints, it was not possible to collect more participants for this study, but it should be repeated with a larger sample size to test further replication of these effects.

In the stick conditions, significant correlations were found between bisection bias and CLQ scores in both experiments. In Experiment 1, this correlation existed between proportion bisection bias and scores on the SS subscale. In Experiment 2, this correlation existed between all bisection bias measures and overall CLQ scores. Importantly, all of these correlations were positive, indicating that smaller slopes, and thus larger near spaces, were associated with lower levels of claustrophobic fear, contrary to findings in the laser condition. We expected that larger near spaces would be associated with higher fear levels, as implied by results in the laser condition and previous research (Lourenco et al, 2011). This positive correlation was also seen between bisection bias and state-level claustrophobic fear (as measured with the behavioral tasks) in the stick condition in Experiment 2. This correlation was found between bisection bias and scores on the mask behavioral task, specifically. Again, this positive correlation denotes that smaller slopes, and thus larger near spaces, were associated with lower claustrophobic fear scores on the mask task. What might account for these positive correlations? A possible explanation could be that near space representations, in individuals with higher levels of claustrophobic fear, are not particularly malleable.

Individuals with high levels of fear could have stagnant, inflexible near spaces, which could be a possible explanation for why trait and state-level claustrophobic fears did not increase in the stick condition. In the stick condition, we expected individuals to have flexible near space representations, allowing them to experience near space enlargement following tool use, as in past research (Berti & Frassinetti, 2000; Gamberini et al, 2008; Longo & Lourenco, 2006; Serino et al, 2007). For individuals with higher levels of claustrophobic fear, however, the stick manipulation may have had little effect on the size of their near spaces. Conversely, individuals with low levels of claustrophobic fear may have flexible representations, with near spaces showing greater enlargement. This may have resulted in typical, lower-fear individuals exhibiting larger near space representations during line bisection, and higher-fear individuals exhibiting smaller (or unaltered) near space representations.

Flexibility of near space representations could be a causal factor for claustrophobic fear, in addition to (or in place of) the "size" of near space. It has been suggested that the function of near space is to act as a protective buffer around the body to plan and coordinate defensive behaviors (Berti & Frassinetti, 2000; Gamberini et al, 2008; Graziano & Cooke, 2006; Longo & Lourenco, 2006, 2007; Lourenco et al, 2011). Graziano and Cooke suggested that near space representation could enlarge in threatening situations, and reduce to a smaller size in safer situations. This ability to flexibly alter near space representations based on context better allows individuals to assess the relative safety or threat of their surroundings. If individuals with higher levels of claustrophobic fear have less flexible representations of near space, they might not be able to easily adjust their representations in different contexts, perhaps even resulting in poor assessments of the relative safety of different situations. If unable to alter spatial representations to analyze or deal with these situations, it is logical that individuals would experience increased levels of fear in a broader range of situations. In other words, inflexibility of near space representation could cause claustrophobic fear (and other spatial fears), not just because these representations are overly large, but because individuals are less able to alter near space in a way that they can analyze the threat in different contexts and safely respond to it.

The alternate explanation for these positive correlations could be that near space representation was not a causal factor for claustrophobic fear, and that, instead, claustrophobic fear drives alterations in spatial representation. This proposition that fear was the causal factor, rather than the other way around, is supported by previous research in which spatial representations were influenced by the amount of fear experienced in certain situations (Stefanucci & Proffitt, 2009; Stefanucci et al, 2008). In this previous research, participants overestimated vertical distances and steepness when in more fear-inducing situations. This research focused on acrophobic fear (fear of heights), which is a fear often co-morbid with claustrophobia (and, in fact, acrophobia (AQ) scores correlated strongly with CLQ scores in Experiment 1). Claustrophobic fear could influence near space representations in a similar manner as acrophobic fear influenced spatial representations in these previous studies – that is, higher claustrophobic fear could lead to enlarged near spaces. Further research should be carried out to test if claustrophobic fear can cause changes in representations of near space, as this direction of causality was not examined in the current study.

Further research should also focus on the flexibility of near space representations to directly test the flexibility of near space in different individuals and situations. A within-subjects design would give a more striking demonstration of the ability to manipulate near space representation within an individual and eliminate potential confounding differences between conditions. In the current study, slopes of bisection bias for the stick condition were also significantly greater than zero, while in past research these slopes were much flatter (Longo & Lourenco, 2006; Lourenco et al, 2011). This may suggest that the stick manipulation did not work as well as in previous experiments, which could be due to the posited idea of inflexibility in individuals with high claustrophobic fear, or an intrinsic problem with the line bisection task. Following the possible idea that near space representation in individuals with high claustrophobic fear could be inflexible, is it possible to alter this representation through tool use (or any other means)? Perhaps individuals with high claustrophobic fear would need a longer period of exposure with the tool to observe near space enlargement, or perhaps a new task needs to be designed to test these effects. If it is possible to alter near space representations in individuals with high levels of claustrophobic fear, and this space is more inflexible in this group, perhaps the effects of enlargement would be more permanent or take longer to wear off.

These findings may have broader implications for the psychological field and the treatment of claustrophobia. The present study was based on suggestions that wrist weights might serve as a possible treatment for claustrophobia (Lourenco et al, 2011). This idea was premised on a causal connection between claustrophobic fear and near space representations, with larger near spaces leading to higher claustrophobic fear; thus, this overly large near space representation could be contracted with weights placed on the arms, as demonstrated in a previous study examining contraction (Longo & Lourenco, 2009). In light of the findings of the present study, this may not be a logical treatment option for people suffering from claustrophobia, as wrist weights could only treat claustrophobic fear if distorted near space representations are a causal factor for this fear, and these spatial representations are flexible enough to be altered with weights. Other potential useful treatment options may be to focus on increasing awareness of how individuals make spatial representations, especially in near space. Individuals could receive training to better approximate the actual "near-ness" of their surroundings and the amount of threat situations actually present, then practice distinguishing these representations from internalized spatial representations. This could explain why cognitive behavioral therapy (CBT) is already a common treatment for claustrophobia (Beck, Emery, & Greenberg, 2005; Rachman, 1997; Thorpe et al, 2008), since it highlights how psychological problems arise from the ways in which individuals interpret and evaluate situations. The present study may lend support for this kind of therapy and possibly suggests therapists could focus on addressing spatial representations in this type of therapy, in addition to addressing other internal processes through which claustrophobic fear arises.

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Endnotes

1. Four participants reported less than 20/20 vision, but not to an extent that would hinder their performance on the line bisection task.

2. Experiment 1B: A pilot study was conducted with ten participants in an attempt to increase the effect of the stick manipulation (6 female; $M_{age} = 19.82$, $SD = .972$). This was done because bisection bias slopes in Experiment 1 were significantly different from zero, while previous research suggested these slopes should be completely flat (Lourenco et al, 2011). All participants were placed in the same line bisection condition, in which they received thirty-six laser pointer trials, followed by thirty-six stick trials, thus exposing participants to the contrast between the laser and stick conditions. However, bisection bias slopes for this within-subjects contrast were not significantly flatter than in Experiment 1 ($ps > .60$), so in Experiment 2 we converted back to the original between-subjects design.

3. One participant was legally blind in one eye; however, data for this subject appeared normal, so she was included in the analyses.

4. If participants were not willing to attempt a behavioral task, they still predicted fear for that task but did not report fear levels after the task. This only occurred in two participants, both of which chose not to attempt the mask task.

Tables and Figures

Table 1

Mean scores on the CLQ (SS and RS subscales) as a function of condition in Experiment 1.

Claustrophobia Questionnaire	Condition			
	Laser		Stick	
	Mean	SD	Mean	SD
Overall CLQ	32.278	11.57	38.667	17.16
SS Subscale	11.22	5.52	14.33	7.51
RS Subscale	21.06	7.26	24.33	10.22

n = 18 for both conditions.

None of the means differed significantly from one another (all *ps* > .10)

Table 2

Claustrophobia Questionnaire Means for Experiment 2.

Claustrophobia Questionnaire	Condition			
	Laser		Stick	
	Mean	SD	Mean	SD
Overall CLQ	42.188	17.31	31.177	14.80
SS Subscale	17.25	8.05	12.06	7.83
RS Subscale	24.94	10.62	19.12	8.03

For the laser condition, $n = 16$. For the stick condition, $n = 17$.

None of the means differed significantly across condition (all *ps* > .05)

Table 3

State-level measures of claustrophobic fear. Means and standard deviations reported by condition in Experiment 2.

Behavioral Tasks	Condition: Laser Mean	Laser SD	Stick Mean	Stick SD
$Straw_{Predicted}$	8.643	11.40	18.824	27.16
$Straw_{Reported}$	11.714	15.57	13.353	14.28
$Mask_{Predicted}$	18.786	23.66	22.882	24.54
$Mask_{Reported}$	22.071	25.76	13.000	14.89
$Bed_{Predicted}$	3.357	4.20	6.412	10.20
$Bed_{Reported}$	1.571	3.03	5.353	10.66
$Bag_{Predicted}$	7.143	13.72	12.529	16.21
$Bag_{Reported}$	10.786	18.81	8.882	17.08

For the laser condition, $n = 16$. For the stick condition, $n = 17$.

None of the means differed significantly across condition ($p > .20$)

Table 4

Correlations between behavioral tasks (state-level) and the CLQ (trait-level) assessments of claustrophobic fear in Experiment 2.

	Behavioral Tasks							
	Predicted Fear				Reported Fear			
Claustrophobia Questionnaire	Straw	Mask	Bed	Bag	Straw	Mask	Bed	Bag
Overall CLQ	.441*	.593**	.501**	.272	.569**	.630**	.329	.399*
SS Subscale	.519**	.612**	.540**	.208	.550**	.614**	.446**	.412*
RS Subscale	.322	.506**	.409*	.294	.518**	.582**	.191	.340

$^{**}p < .01$; $^{*}p < .05$

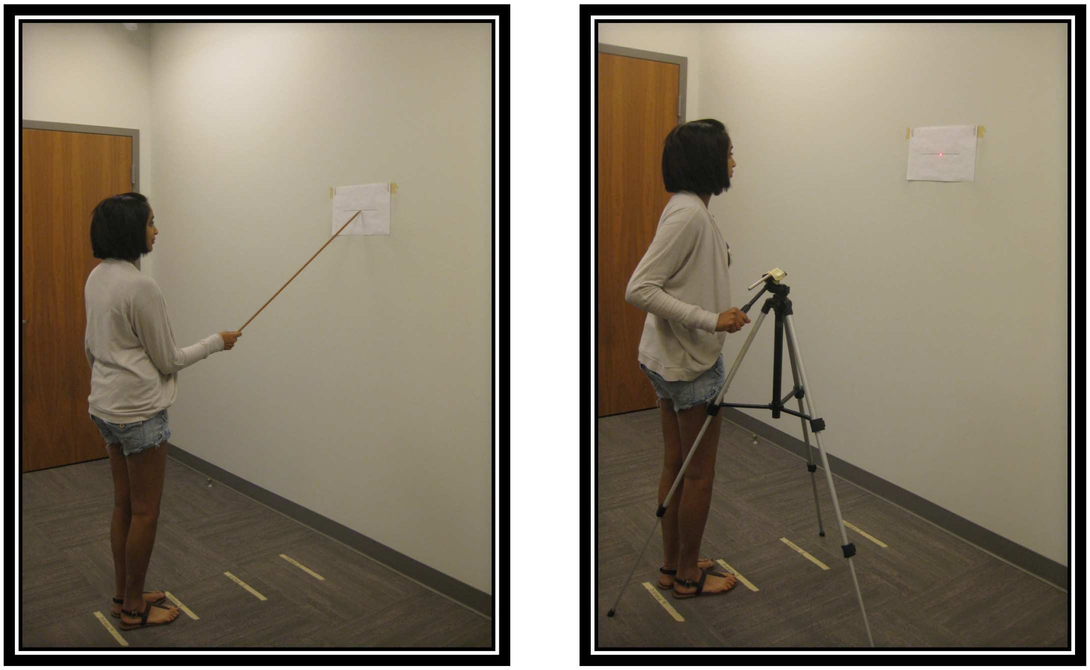

Figure 1. The experimental (stick) condition (on left) and the control (laser) condition (on right) of the line bisection task. The participant is standing at distance three (90 cm) in both conditions.

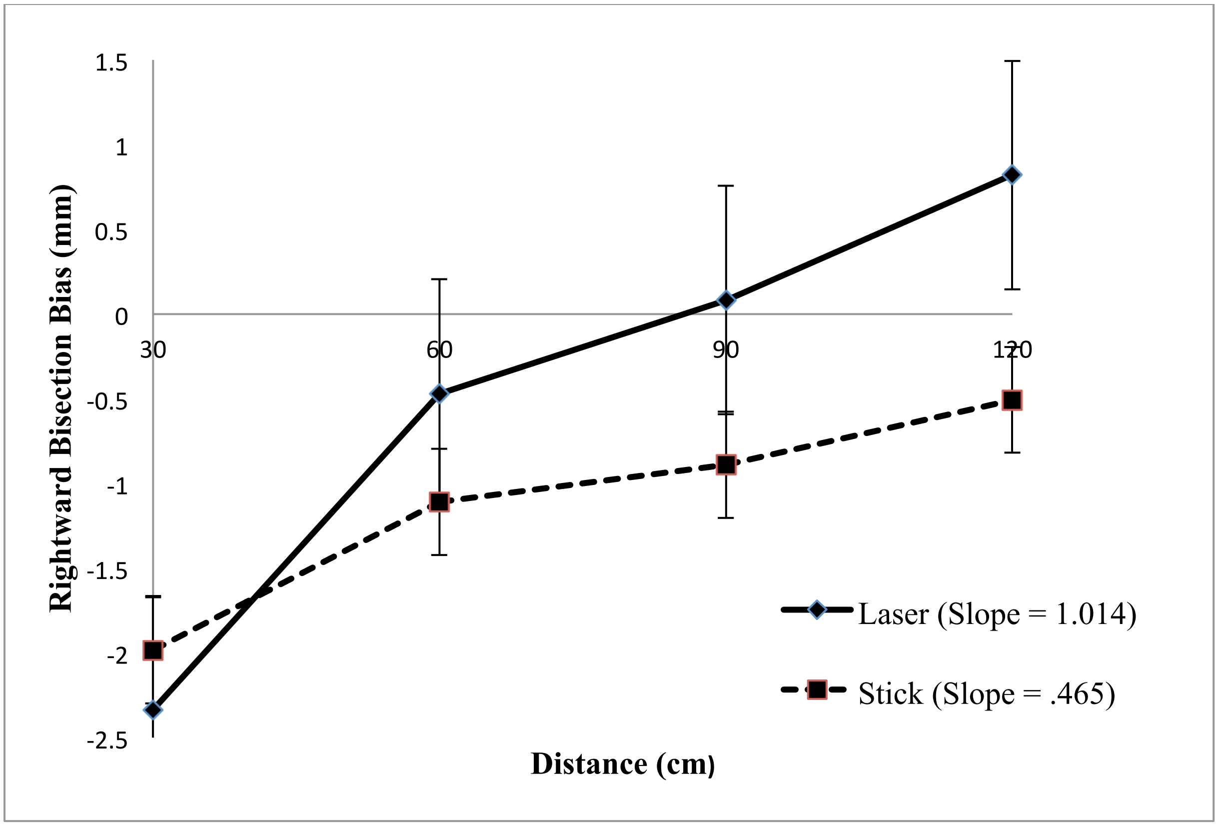

Figure 2. Experiment 1: Absolute bisection bias shifts rightward with increasing distance. The stick condition shows a leftward bias at all distances, implying enlargement of near space. Slopes for the laser and stick conditions differed significantly ($F(1,34) = 7.357$, $p = .01$). Error bars represent standard error at each distance.

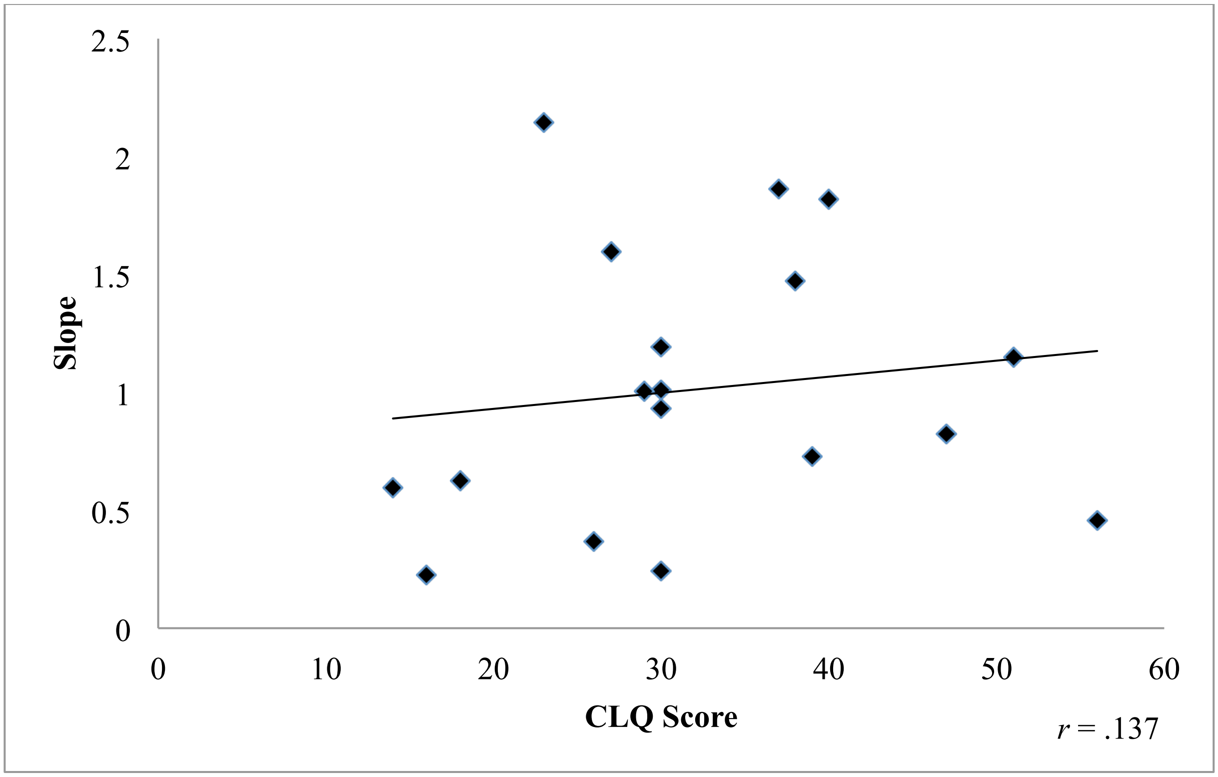

Figure 3. The correlation between overall CLQ score and absolute bisection bias for the laser condition in Experiment 1 is not significant ($p > .50$). $n = 18$.

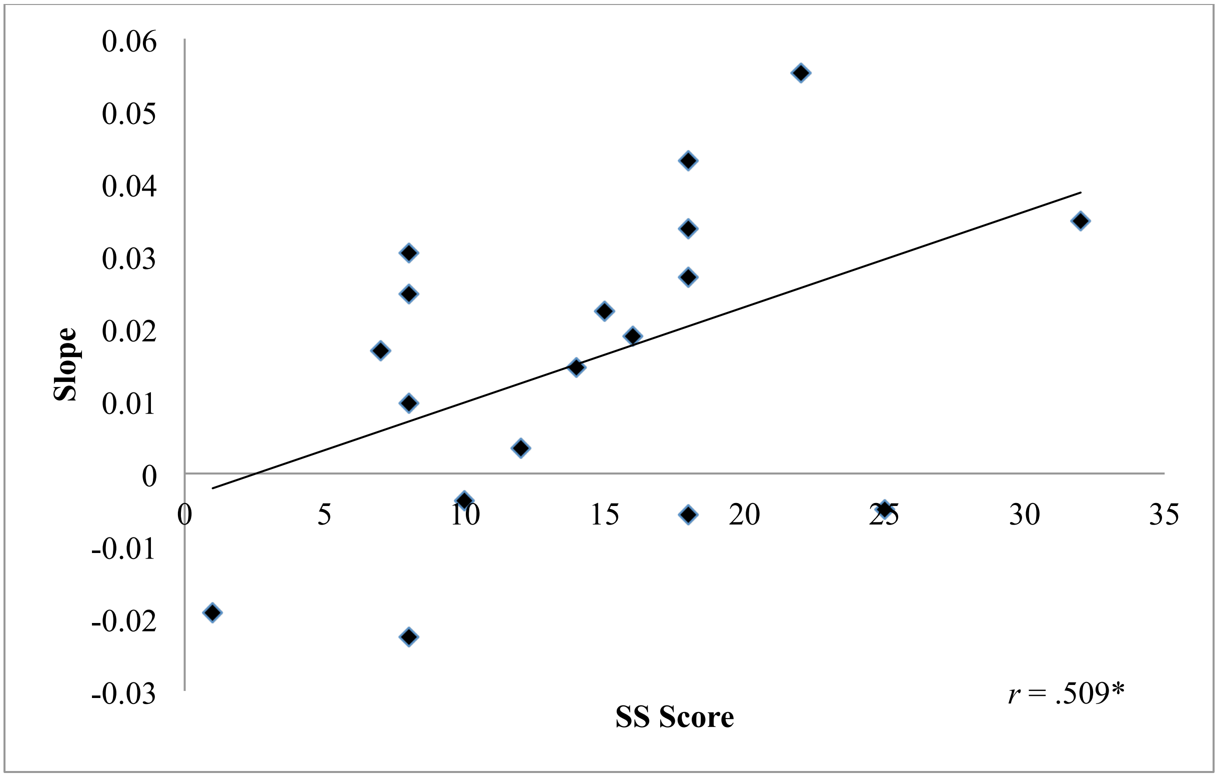

Figure 4. The correlation between scores on the SS subscale of the CLQ and proportion bisection bias for the stick condition in Experiment 1 is positive and significant ($p = .031$). $n = 18$.

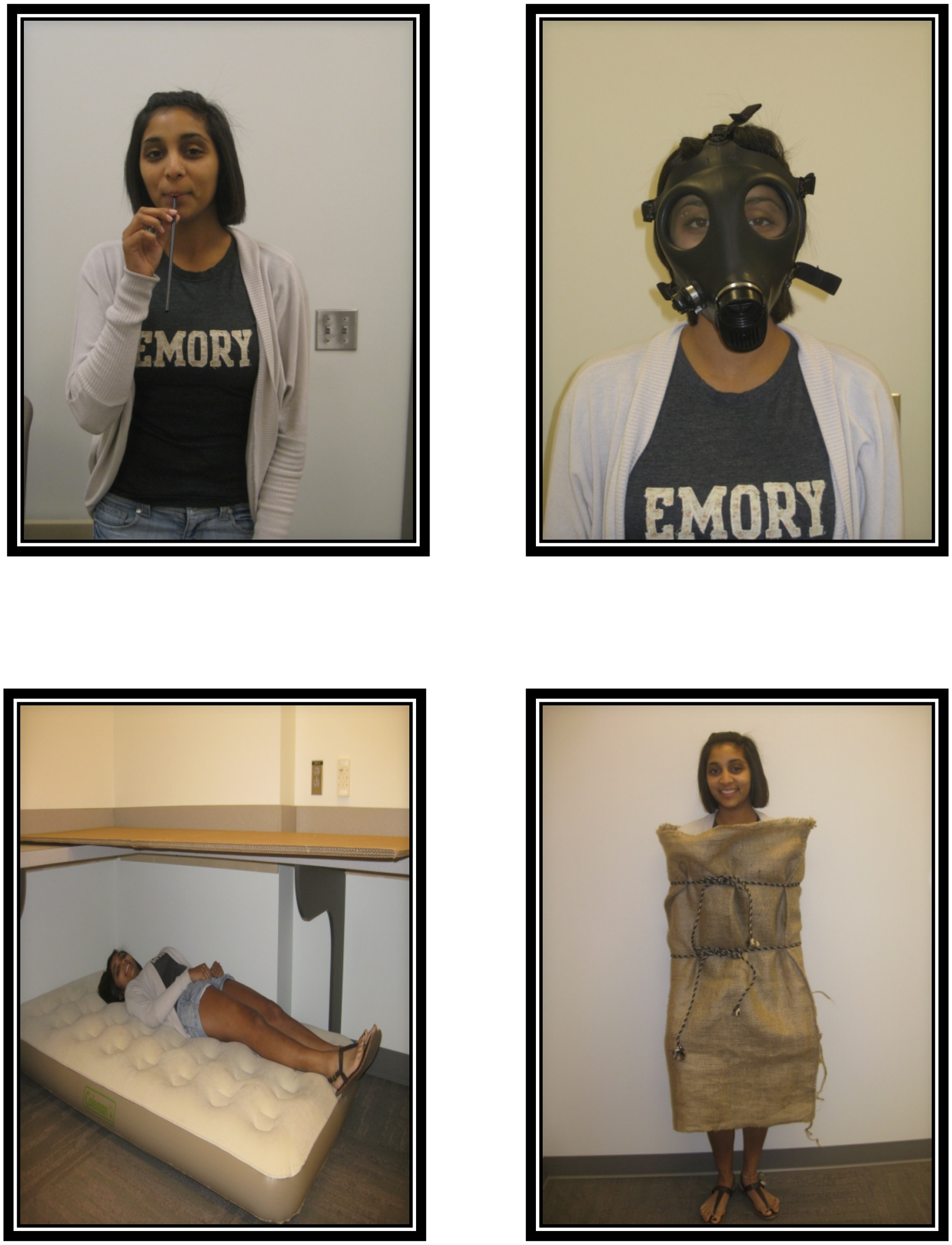

Figure 5. Behavioral Tasks for Experiment 2: Straw (top left), mask (top right), bed (bottom left), and bag (bottom right).

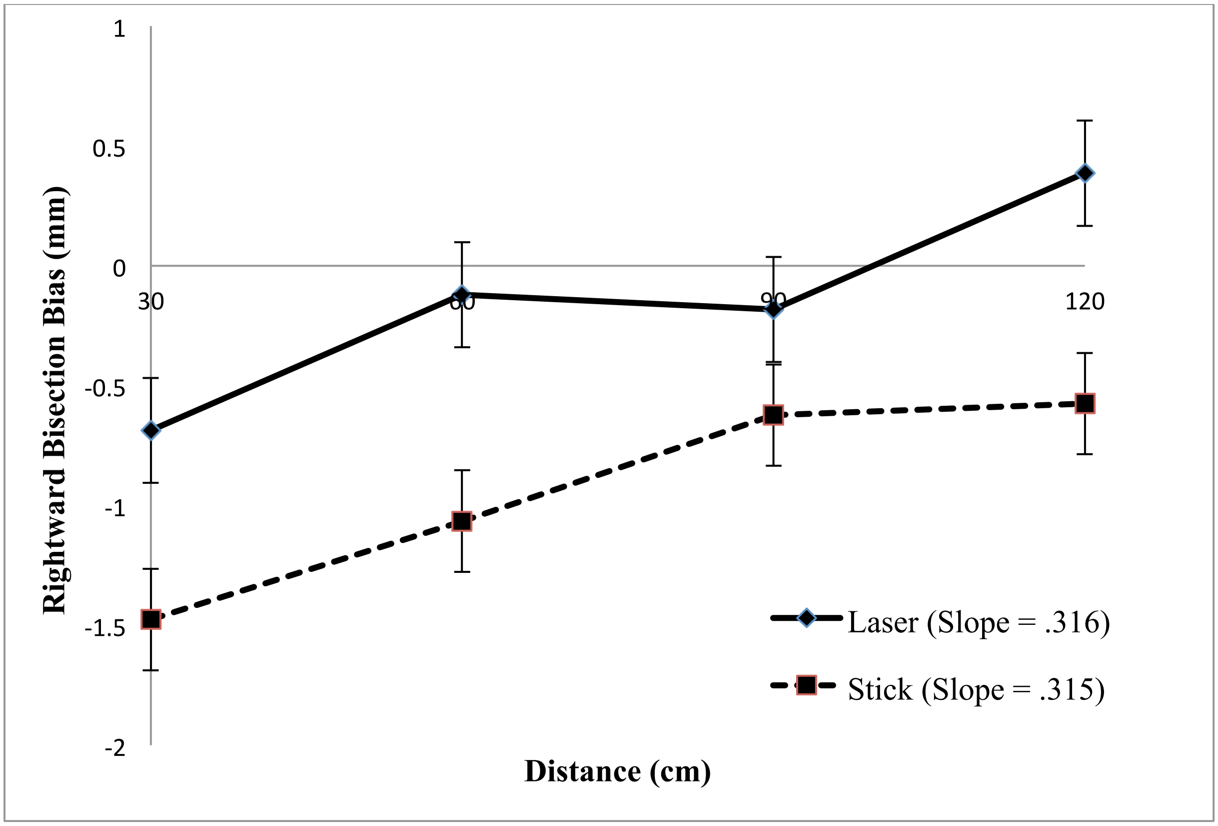

Figure 6. Experiment 2: Absolute bisection bias shifts rightward with increasing distance. The stick condition shows a leftward bias at all distances, implying enlargement of near space. However, slopes for the laser and stick conditions did not differ significantly ($p > .20$). Error bars represent standard error at each distance.

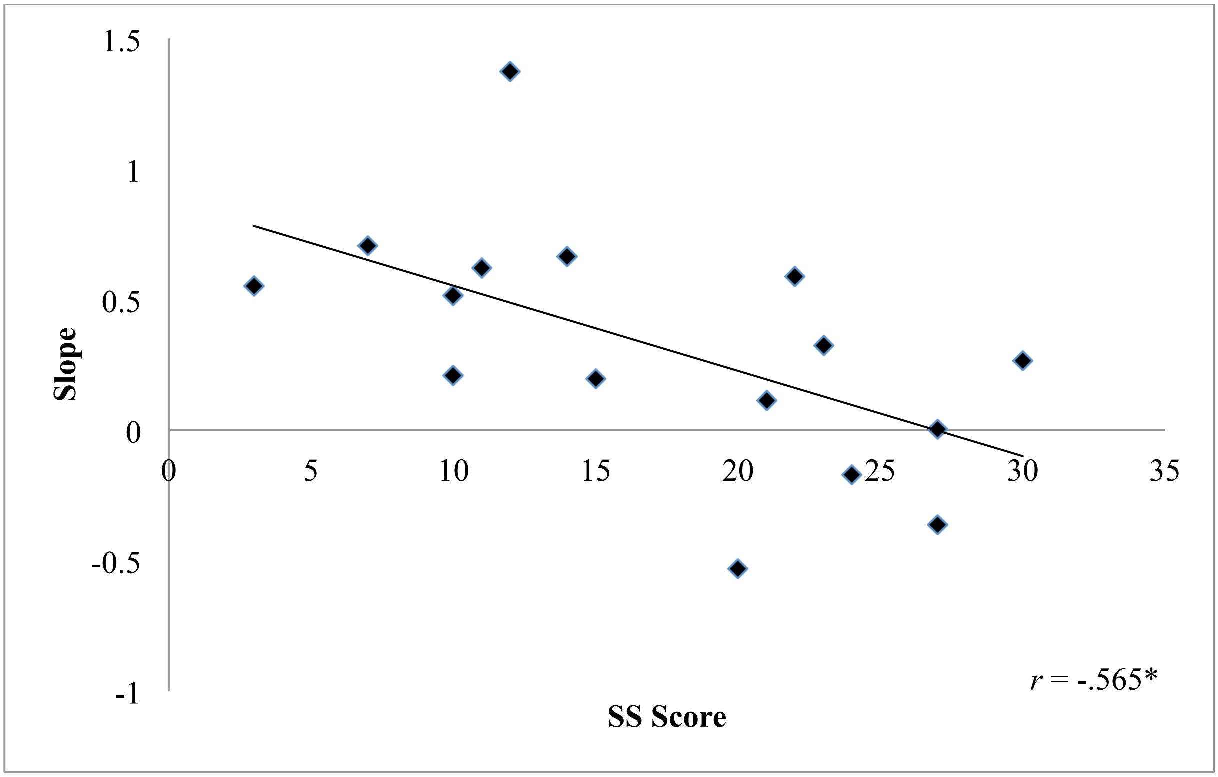

Figure 7. The correlation between scores on the SS subscale of the CLQ and absolute bisection bias for the laser condition in Experiment 2 is negative and significant ($p = .023$). $n = 16$.

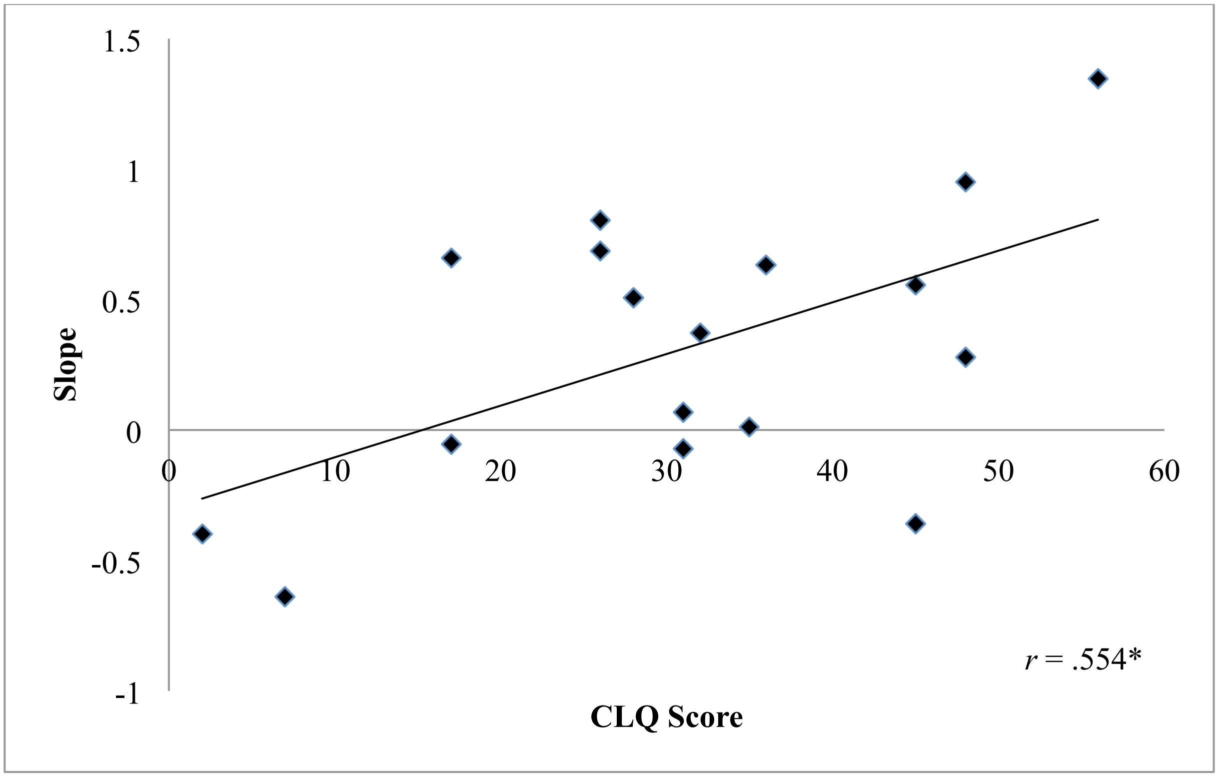

Figure 8. The correlation between scores on the overall CLQ and absolute bisection bias for the stick condition in Experiment 2 is positive and significant ($p = .021$). $n = 17$.

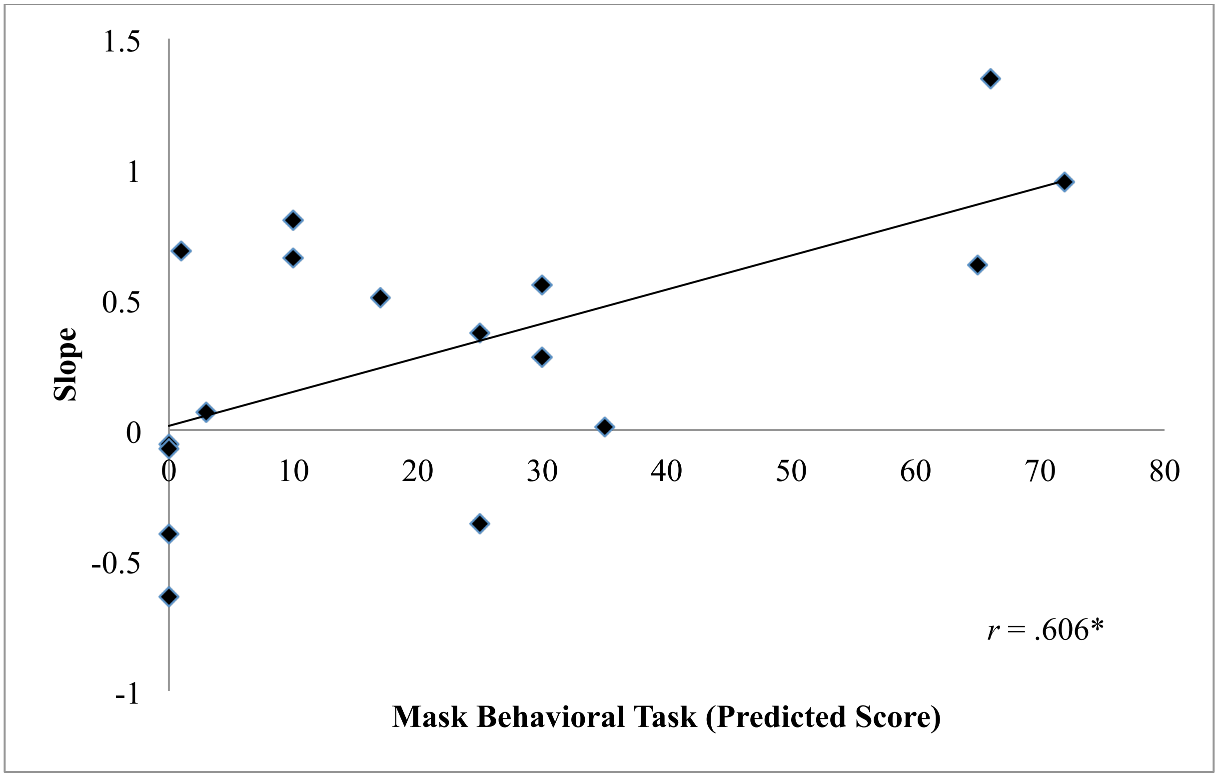

Figure 9. The correlation between state-level predicted scores on the mask behavioral task and absolute bisection bias for the stick condition in Experiment 2 is positive and significant (p = .010). n = 17.