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The Interaction Between the Physical Environment and Metaphysical States: The Role of Social Anxiety and Stress in Informing Spatial Perception

by

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Presented in Partial Fulfillment of the

Requirements for Independent Study Thesis Research

Supervised by

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Abstract

The current study looks at the interaction between social anxiety, stress, and spatial perception. The hypothesis is that under stress, participants will see an anxiety-provoking stimulus as closer and larger and perceive themselves as shorter, particularly if they are higher on the social anxiety scale. Participants either did a variation of the Trier Social Stress Test or were in a control group, and then estimated spatial properties of a social stimulus, a video camera, as well as estimates of their own height. Finally, participants completed self-reported stress measures, the shortened Spielberger State-Trait Anxiety Inventory (STAI) and the shortened Social Interaction Anxiety Scale (SIAS). Results indicated a marginally significant trend for the stress condition perceiving the video camera as smaller and further away, a significant trend for participants with social anxiety seeing the video camera as significantly larger, and certain subsets of social anxiety accounted for seeing the video camera as closer. There was no interaction between stress and anxiety on spatial estimates. Finally, participants who were upset perceived their self-height as shorter than their actual height. Results distinguish the role of stress and social anxiety in driving perception to prepare an individual for action, and implications are discussed in the realm of therapies for social anxiety.

Introduction

Anxiety disorders are the most common mental illness in America, affecting 40 million, or 18%, of adults in the United States (Denollet & Kupper, 2012). Of that, 6.8% have a social anxiety disorder. Social anxiety disorder, or social phobia, is characterized by a fear of being judged and embarrassed by others that is so overwhelming that it often gets in the way of doing everyday things that involve people. Thus far, social anxiety has overwhelmingly been treated at the neurological level, in which doctors prescribe anti-anxiety and anti-depressant medications in order to counter the social anxiety. This supports the reliance on addicting medications that are often abused, and does not encourage the individual to integrate socially, which is the principal goal for people with this disorder. Therefore, a new approach to viewing social phobia may arise from looking at the disorder through a perceptual lens. What if social anxiety causes individuals to actually perceive their social environment differently at a physical level?

According to Tajfel's social theory, identity is how we define ourselves based on our methods of filtering the world. This occurs not just at a psychological level, but also extends to how we see ourselves in relation to the physical world (Kriesberg & Northrup, 1989). Again and again, research confirms that people are not in full conscious control of their perception and even frequently misperceive important parts of their environment based on filters. For example, one's arousal and fear can influence one's perception of approaching stimuli. People tend to underestimate the collision time for scary snakes more than docile bunnies (Longo, Lourenco, & Vagnoni, 2012). People think their perception of time and distance is accurate, but in reality it is highly swayed by individualized fears, emotions, and other internal states and motivations. This paper explores how the perception of one's self is biased in the face of threat, how subconscious psychological phenomenon can be applied to one's perception of the physical world, and the

potential role of differential internal states such as stress and social anxiety on driving perception.

Implicit and Embodied Cognition

Typically, social behavior seems fully under the individual's control. There may not be a direct thought to behave a certain way, but it at least seems conscious. Evidence, however, is slowly starting to support a contrary view that social behavior can frequently be implicit and even unconscious (Banaji & Greenwald, 1995). Implicit cognition explains how past experiences influence judgments without the individual's awareness. These unconscious influences can include knowledge, perception, self-esteem, stereotypes, attitudes, and memory. For example, when looking at a complex visual scene, there is a tendency to look at the stimulus that is more familiar, self-relevant, or ecologically salient. Stimuli can also be primed at a subconscious level and then found quicker in the visual scene without an individual's awareness (Chun & Jiang, 1998).

Implicit cognition can furthermore be used as a strategy to decrease anxiety. Individuals with social anxiety can learn to pair self-relevant stimuli to faces in order to indicate positive social feedback, which then decreases their anxiety as tested by social stress tests (Clerkin & Teachman, 2010). There are so many mechanisms behind anxiety disorders that are extremely hard to bring to consciousness. Therefore, triggering implicit connections that change the way individuals with social phobia perceive themselves and others can be beneficial for discovering the multitude of mechanisms that form the disorder.

Another theory that regards social behavior under implicit control is the embodied cognition approach to behavior. According to this theory, the mind and body interact in reciprocal, yet often unconscious, ways (Eastwick & Finkel, 2009). For example, putting one's

hands under a table and pulling upward causes stimuli to appear as more appealing than putting hands on a table and pressing downwards (Berntson, Cacioppo, & Priester, 1993). Simple physical motions actually cause changes in internal cognition. Whereas pulling is associated with approach, pushing is associated with avoidance. Therefore when engaging in physically approaching actions, our mental thoughts are subliminally changing to cater to those movements. If an individual is socially distressed, the act of literally taking one step towards a crowd of people may be enough to trigger approach instincts at a psychological, not just physical, level.

Implicit cognition shapes our thoughts based on external input and internal cycles and embodied cognition alters thoughts based on physical movement. It is very rare that our thoughts are not swayed by social influences, as the smallest visual input or touch can shape our opinions and feelings without it ever reaching our awareness. The smallest differences in our environment change and shape our views in the most unexpected ways. Even trivial stimulus qualities can alter our behavior. For example, the temperature of the drink in one's hand can alter how they feel about others. The act of holding a hot drink makes people think more warmly of others than when holding a cold drink (Bargh & Williams, 2008). Even feeling the simple texture of stimuli can impact our internal states: Sitting in a hard chair actually makes us feel emotionally harder (Jackson, 2008). There are thousands of physical stimuli just at the edge of our periphery, and our interactions with external stimuli are more involved than what we see at an immediate and functional level.

Motivated perception

Subconscious input and physical body movements impact our thoughts and decisions, so how do internal thoughts influence our body and perceptions of the external world? If physical movement can implicitly influence psychological beliefs, then it makes sense that a reciprocal

influence could occur. Similar to the embodied approach example of how holding a hot drink makes us feel warmer about new acquaintances, the intangible feelings of social exclusion, often associated with pain, depression, and anxiety, are literally reported to feel cold (Leonardelli & Zhong, 2008). Our physical body informs our mind of stimuli, which then alters internal states, and those states in turn inform our physical body.

Previous experiments in implicit cognition reveal that physical approach or avoid tactics based on pushing and pulling alter perception of stimuli, and further experiments do show a reciprocal process. In a study by Beek and Stins (2011), participants viewed stimuli of different valence, and either stepped forward or backwards on a force plate. Results demonstrated that viewing unpleasant images caused an initial "freezing" response and a physical reaction of avoidance or moving away. Pleasant stimuli on the other hand caused a physical approach reaction. So physically moving toward a stimulus causes one to have a mental approach model, and having a positive internal state causes physical approach. The same trend applies for avoiding stimuli.

Certain mental states may also influence and alter one's perceptions of time and space. Perceptions are influenced by a plethora of internal factors, and one such factor is emotion. Unconscious processing of emotional stimuli causes an altered perception of time. Time thus far is identified as a cognitive process that does not have a direct sense organ to process it (Kawabe & Yamada, 2011). Therefore, it is hypothesized that there is more room for internal states to influence our perception of time. Using emotional stimuli flashed on a screen, Kawabe and Yamada (2011) found that positive or neutral imagery leads to accurate perceptions of stimuli duration, but negative emotional stimuli causes an accelerated internal clock. In contrast, the perception of stimuli under stress and fear often causes a slowed internal clock. The slowing of

the internal clock by means of stress is actually moderated by anxiety. In response to the threatening stimuli, there is a greater time dilation in anxious people than nonanxious people (Bradley, Mogg, McNamara, Powys, Rawlinson, & Seiffer, 2000). This research is one of many to find an interaction between stress and anxiety on perception.

The New Look Approach

In order to look at how social anxiety and stress impact perception, first the function of perception must be analyzed. Why is it that perception of the external world is so dependent on internal states? The New Look approach to perception explains biased perception as the need for individuals to organize visual representations of the world based on values and needs (Bruner, 1992). In other words, needs and values drive perception so that one can be better prepared to respond to stimuli. For example, when one physically wears a heavy backpack, one perceives the slant of a hill at a greater angle (Proffitt, 2006). Wearing a backpack increases the metabolic costs of walking, and therefore the hill is perceived as steeper to accommodate these costs. In this sense, perception is useful because it subconsciously distorts the environment to inform people about the costs of an action.

Researchers used the same heavy backpack paradigm to take the cost of action theory one step further in conjunction with James Gibson's theory of affordances (Banton, Epstein, Proffitt, & Stefanucci, 2003). According to the theory of affordances, visual perception is guided by the opportunities for action provided by a given environment. Gibson believed that perception is not guided by internal sensation but rather by outside information. Banton, Epstein, Proffitt, and Stefanucci (2003) combined theories of locomotor effort and distal extent to gain an understanding of distance perception. Again using the backpack paradigm, they discovered that the line between perception and action is not as clear as anticipated. Perception informs action,

action informs perception, and over time the distinction can be hard to discern.

If wearing a physical backpack can cause changes in one's perception of physical space, then what are the implications for wearing a "metaphorical backpack", or simply the feeling of losing resources without the physical restraints? When one wears a metaphorical backpack, the same trend in perception occurs. Induction of sadness leads to a feeling of lost resources, and this emotional draining causes hills to be viewed as steeper to accommodate for the emotional costs (Proffitt, Riener, & Stefanucci, 2003).

Feeling, and physically experiencing, a loss of resources leads to perceptual changes of the environment to inform the individual of the costs of action. However, sometimes the perception of the environment is altered in order to help fulfill needs and goals through self-regulation. For example, when people are thirsty they perceive water as closer than when they are not thirsty (Balcetis & Dunning, 2010). This is an influence of higher level cognitive dissonance on perception. Here, cognitive dissonance refers to cognitions conflicting with the actual perceptions of the environment. One desires water due to thirst, but this desire conflicts with the water's position at a set distance from the participant. Water is clearly not closer to people when they are thirsty, but in order to compensate for their thirst they see the thing that can relieve their thirst as closer.

Altered distance perception based on need fulfillment is not limited to rudimentary human needs, it also extends to positive and negative feedback on assessments. Balcetis and Dunning (2010) gave participants either positive false feedback or negative false feedback. Then they put the physical assessment on a table a fixed distance away from participants, who perceived the assessment to be further away when it contained negative feedback than when it contained positive feedback. The desirability of the item, regardless of its physical qualities,

affects how close the viewer perceives it. Higher desirability translates to perceiving the desirable item as closer.

The interaction between distance perception and internal states becomes even more dramatic when it involves chronic phobias. Phobias are associated with high arousal, which is demonstrated in the literature as a cause of more dramatic distance estimates. Steffanucci and Storbick (2009) conducted a study looking at how priming emotion through arousing and non-arousing images influences height estimation from a high balcony. Participants who viewed arousing pictures, regardless of valence, overestimated the distance between themselves and the ground and estimated the size of the target to be larger. The stress involved with height phobias interacts with primed arousal to cause different height estimates (Stefanucci & Storbeck, 2009). However, in order for arousal to influence perception when the source of arousal is unrelated to the perceptual environment, the environment must contain a cost for action, like the extreme height in this study.

Under fear of great heights, a stimulus is perceived as larger, which may attribute to the cost for action, for if the ground is perceived as both closer and larger, one's ability to react to the situation is enhanced. The size of a stimulus is a very important perceptual tool. In a social atmosphere, internal thoughts and judgments can influence one's perception of stimulus size (Koomen & Stapel, 1997). A tool used to test perceptions of size, particularly related to social stimuli is the Ebbinghaus illusion. This is a diagram that represents two of the same sized circles in the context of either larger or smaller circles.

A clever study used the Ebbinghaus illusion, but loaded positive or negative information onto the surrounding circles (Beek, Oudejans, Semin, & van Ulzen, 2008). Regardless of whether the circles were embedded in larger or smaller circles, the negatively loaded targets

were seen as significantly larger than the positively loaded targets, as they needed to be attended to more quickly. This falls in line with evolutionary theories that posit that negative stimuli needs to be attended to more quickly than positive stimuli since it is more adaptive to avoid dangers than to approach positive stimuli. Therefore stimuli may be perceived as larger to trigger this adaptive response in times of danger. However, stimuli may also be perceived as larger if it is more valuable. This is similar to how water is perceived as closer when one is thirsty because in this case the adaptive stimulus is the valuable stimulus (Bruner & Goodman, 1947). Therefore, from an evolutionary perspective, if a stimulus is threatening or associated with a threat it is typically seen as larger, but if no threat is present, its value can then be associated with its perceived size.

Neural Coordinates of Fear, Anxiety, and Stress

Distance perception can be examined through the lens of defensive direction. Arousal affects decisions by increasing the effect of negative stimuli on decision (Corr & McNaughton, 2004). There is a reliable distinction between the functional, behavioral, and neurological processes of fear and anxiety. Fear has the function of moving animals or humans away from danger and therefore it is triggered under aversive contexts by which fear is evolutionarily salient. It involves fight-or-flight and/or freeze responses, which are completely automatic responses (Mineka & Öhman, 2001). However, when in an approach-avoidance conflict situation, anxiety can have the function of moving toward danger due to coping mechanisms.

Since anxiety is frequently defined as fear in which there is no escape and therefore approaching danger, it is highly associated with the Behavioral Inhibition System, otherwise known as BIS (Gray & McNaughton, 2003). This is a neuropsychological system that explains the reaction to stimuli in the environment that are associated with anxiety. The point of this

system, which works at the level of the hippocampus, is to avoid fear, anxiety, and stress. The Behavioral Inhibition System (BAS) on the other hand works at the dopaminergic level to increase positive emotions, achieve goals, and motivate based on rewards.

The brain processes anxiety and stress in interrelated ways. The neural mechanisms behind anxiety can be split based on conscious and unconscious processing. When stressful stimuli or threats are processed unconsciously, the basolateral subregion of the amygdala is activated and the process is mediated by social anxiety, whereas conscious processing activates the dorsal amygdala and is not affected by social anxiety (Dudman, Etkin, Hen, Hirsch, Kandel, Klemenhagen, & Rogan, 2004). Fear works on the same pathways as anxiety, in which stimuli from visual or auditory pathways enter the thalamus, then the insular cortex then the basolateral amygdala, in which information is specialized in the central and medial areas, and finally the information reaches the brainstem.

Anxiety and fear are both automatic responses that occur at the level of the amygdala. The differentiation between anxiety and fear occurs at the level of the brainstem: Anxiety works on the bed nucleus of the stria terminalis (BNST) and fear on NMDA receptors in the amygdala (Davis, 2006). The BNST is responsible for the freeze response in situations, particularly in the presence of unpredictable stimuli, and this applies more so in anxiety states due to the state of apprehension. The BNST is also responsible for the mediating fear response. NMDA receptors on the other hand are more specifically involved in fear responses, particularly the role of fear in conditioning and learning. Both systems occur in relation to the amygdala, which is key to the activations of stress, anxiety, and fear. Activating the amygdala, especially in the left hemisphere, leads to fearful emotional response, and lesions to the amygdala impair fear conditioning (Calder, Dolan, Frith, Morris, Perrett, Rowland, & Young, 1996).

Anxiety and stress are both studied in relation to social threats, and therefore they should be distinguished. Both anxiety and stress are psychological and physiological, but anxiety is typically the psychophysiological signal of stress, and stress is the resulting response to anxiety. However in addition to being a response, stress can also be a state or even a stimulus. In cognitive psychology, stress is a trigger for a required action (Sarason, 1984). Under this definition, anxiety is then the fear associated with the inability to adequately respond to the stress. In social phobias, the stress of being in public triggers anxiety when one cannot be removed from the social situation.

At the neural level, these negative emotions can be directly linked to spatial perception. The hippocampus is the primary area for spatial recognition. The hippocampus is crucial for our sense of familiarity when seeing something that we have been exposed to previously, and for understanding spatial arrangements. It is furthermore the location for the cognitive map theory and the configural association theory (Breedlove, Watson, & Rosenzweig, 2010). According to the cognitive map theory, the hippocampus constructs and stores allocentric maps of the world using place, grid, and border cells that fire to specific environmental cues. The configural association theory postulates that the hippocampus is involved in retaining the behavioral significance of combinations of stimuli. This is important because research has found that stress causes atrophy and neuronal death in the hippocampus, which has implications for the effect of long-term stress and anxiety on spatial perception (Hahm, Lee, Lee, Park, Yeom, & Yun, 2002).

Inducing Social Stress

In order to look at the role of social stress and anxiety on spatial perception, a reliable means of inducing social stress must be used. There are multiple ways to induce stress by means of increasing cortisol levels, such as the cold pressor task, which involves dipping a participant's

arm into freezing cold water for up to four minutes (Anton, Kuehl, Michaux, & Streff, 2010). However, in order to emphasize social stress within an uncomfortable social situation that highlights one's awareness of identity, the TSST (Trier Social Stress Test) is a highly reliable method.

In a stand-up comedy, Jerry Seinfeld said, "A recent survey stated that the average person's greatest fear is having to give a speech in public. Somehow this ranked even higher than death, which was third on the list. So, you're telling me that at a funeral, most people would rather be the guy in the coffin than have to stand up and give a eulogy." (Goodreads inc., 2012) Clearly, this is a joke, but according to a Gallup poll (Brewer, 2001), about 40% of people are afraid of public speaking, making it the second greatest fear after snakes. The TSST captures this social fear of public speaking empirically.

The TSST involves participants giving a free speech and completing math problems in a highly stressful social setting. In order to prompt an evaluative self-focus, subjects deliver a speech in front of a microphone on a podium in the presence of a video camera, as their performance is critiqued and evaluated. This test primes a self-evaluative awareness within a social context, so it not only reliably causes increases in perceived social stress, but also anxiety and emotional insecurity.

The role of social anxiety is similar to social stress in that individuals who are socially anxious also demonstrate high levels of arousal in social situations, which should then be amplified by the TSST. A study by Eckmen and Shean (1997) looked at how differences in anxiety affected arousal during a speech, and found that individuals who were less anxious had decreased reported nervousness, heart rate, and sweat activity and actual heart rate across multiple speech trials, whereas individuals with high anxiety maintained a constant level of these

variables, indicating that unlike individuals with low anxiety, they are slow to decrease cognitive and autonomic responsiveness in stressful social situations. Therefore, the interaction between social anxiety and social stress may provide some interesting results in perception due to the variance in responsiveness and arousal.

The Trier Social Stress Test has not been used in previous research in relation to spatial perception, but it has been used to test the effects of stress on spatial ability. Stress has an adaptive response for spatial learning. Under stress from the TSST, people use more stimulus-response strategies, which locate stimuli by using stimuli directly next to a cue, and less spatial strategies, which aid in locating a cue based on environmental cues (Bohringer, Schachinger, Schwabe, Oitzl, Philippsen, Richter, & Wippich, 2007). Since stress occupies a large amount of attentional resources, stress causes more reliance on habit and less reliance on cognitive ability. Under stress, attention is narrowed and simplified in order to cope and prepare for action, and therefore a simple stimulus response strategy may be more adaptive than a more cognitively loaded spatial strategy.

Social Stress, Threat, and Distance Perception

Stress is an internal motivator for the perception of the external world. Stress can be induced by means of an organized situation or by the use of a mental model, and perception can also be physical or mental. Since stress indicates a fearful situation that cannot be avoided, stress is often related to feeling as if the stressful stimulus is egocentrically closer. Research has found that when people dance in front of an audience, a stress-inducing activity, the event itself feels psychologically closer than when in an observing social role that is less emotionally arousing (Dale, Kane, McGraw, & Van Boven, 2010). Psychological distance here was measured on a scale from 1 to 10, 1 indicating the dancing seemed very close and 10 indicating very far. Two

findings from this study bolster the causal role of emotional intensity in reducing perceived psychological distance. First, the emotional intensity was negatively correlated with the perceived psychological distance of the event, and emotional intensity mediated the effect of the arousing social role on perceived psychological distance. Both arousal and emotional stress cause stressful situations to feel closer to the self. Can this perceived distance of stress be extended to physical distance of stressful stimuli?

A study on social threat produced reliable correlations between threat and distance perception. Bave and Xiao (2012) conducted two studies looking at the role of in-group and out-group threats on distance perception. In the first study, New York Yankees fans estimated the distance to Fenway Park, the stadium of a threatening out-group to be closer than did non-Yankees fans. In the second study they manipulated identity threat among people affiliated, or not affiliated, with New York University. When Columbia University was portrayed as threatening to NYU, NYU affiliates estimated Columbia as closer than did non-affiliates, compared to when Columbia was non-threatening. Collective identification with the in-group moderated effects of threat on distance estimations. These studies suggest that social categorization, collective identification, and identity threat work together to shape our representations of the physical world. Threatening groups are actually perceived as physically closer and the greater one's identification with the in-group, the greater the out-group threat was, and the closer they perceived the threatening location to be.

Threatening stimuli are typically perceived as closer, which may seem contrary to previous studies such as estimating the distance to a survey containing positive or negative feedback find that less desirable stimuli is seen as further (Balcetis & Dunning, 2010). The discrepancy here is highly based on two things: Arousal and survival. Under threat, there is stress

and anxiety, both of which produce arousal. The arousal of the threat makes threatening stimuli appear larger and closer because avoiding the situation is so difficult that the mind kicks in and brings the stimuli closer in order to increase the chance of confrontation and survival. From an evolutionary standpoint, this is adaptive because any threat to the ingroup must be attended to quicker than any other stimuli, and therefore perceiving the threat as closer is an evolutionary mechanism enhancing survival. Some threatening stimuli like negative feedback on the other hand can be easily avoided and denied and therefore distancing it is adaptive. Therefore, negative stimuli can be perceived as closer or further away depending on the adaptive function of distance.

Underlying Theories for Evaluations of Stimuli under Stress and Anxiety

There are two contradictory hypotheses for how stimuli are perceived based on one's feelings about the stimuli. The first is the positivity-closeness hypothesis, which posits that desirable stimuli are perceived as closer due to agreeable context and undesirable stimuli are perceived as farther because they are disagreeable and therefore cause the individual to wish the stimuli is further away to the extent that the stimuli is actually perceived as further. The second contradicting hypothesis posits that it may be functionally adaptive to represent potentially threatening stimuli as closer than they actually are in order to trigger adaptive behavior (Alter & Balcetis, 2010). If one vividly perceives threatening stimuli as closer, that might give the individual the energy to deal with the stimuli.

A significant component of stress and anxiety that may influence physical perception of stimuli is arousal. Arousal, regardless of positive or negative valence, causes a narrowing of attention such that environmental cues that are not immediately significant are blurred and stimuli salient to the arousal are focused on more strongly (Kitayama & Niedenthal, 1994).

Arousal tends to be higher under stress and negative affect than under positive affect, and therefore stimuli may be perceived as closer when stimuli is negative because it is increasing arousal, which causes a need to respond quickly, attention is honed in on the source, and ultimately the stimulus feels closer and larger.

Another role of emotional arousal in the perception of stimuli is that arousal causes very polarized social evaluations due to more extreme evaluative judgments (Lim & Paulhaus, 2006). Beyond polarized social evaluations, arousal can lead to a generally dichotomized view of the physical world, through which vision is the means for gross underestimations and overestimations of the things around us. This occurs because under arousal, social perception is simplified due to cognitive reduction. For example, both self-judgments and judgments of famous social targets are polarized under arousal (Lim & Paulhaus, 2006). Arousal decreases cognitive ability, which in turn increases reliance on dramatic judgments rather than cognitive evaluations. In Lim and Paulhaus' study, arousal was induced in half of the participants who had much greater variations in response to the likeability of celebrities than participants who were not aroused. Therefore, social judgments and evaluations should be more varied under stress, since stress is correlated with high arousal.

Finally, there is the role of attentional biases in perception. According to the cognitive model of social anxiety, individuals with high social anxiety have an attentional bias towards negative stimuli because they are preoccupied with fulfilling their own cycles of negative appraisal (Clark & Wells, 1995). This is particularly true for words, as evidenced by individuals with social phobia paying more attention to threatening words in a stroop task, which likely occurs because of the associated preoccupied negative self-evaluation.

Self-Perception

It is possible that under dramatic internal states such as arousal or high stress, one may perceive his or her spatial environment differently due to his or her own self-perception. Since spatial environments are relative, spatial stimuli may appear smaller when one feels larger, and larger when one feels smaller. Similar to the perception of external stimuli, the perception of one's physical body and the perception of others can be altered based on internal states as well as external influences.

Height perception is highly dependent on many factors that are unrelated to height, including perceived power, voice characteristics, and gender. For example, people consistently estimate heights based on similar acoustic conditions, even when they are completely wrong. When judging heights based on listening to recorded speeches, only 14% of people's estimated heights of speakers actually correlated with the correct values of heights (Gonzalez, 2003).

On average, everyone overestimates their own height, but females are more accurate at self-reporting height (Hart, Imrhan, & Imrhan, 1996). Overall, simple self-estimates of height and weight are accurate enough to be used in place of measurement (Hart, Imrhan, & Imrhan, 1996). But when motivational factors are involved, people can be influenced to perceive height differently. People have a bias towards being taller, as greater height is culturally perceived as better. Based on height estimations made in inches, individuals of higher academic status are misperceived as being taller than individuals of lower status (Wilson, 1968; Delin & Rump, 1973).

One study looked at the relationship between perceived power and physical height (Duguid & Goncalo, 2012). Pairs of participants were given a leadership test and then randomly assigned either to manager position or employee position. Those assigned to the manager

position overestimated their own height and those assigned to the employee position gave a more accurate height. Perceived power is associated with greater height.

Perception of height is largely influenced by cultural connotations. In the United States, taller men are more likely to be successful (Ervin & Jackson, 1992). Baby boys in Finland who were taller than the average before the age of 1 earned more than those who were shorter, as measured 50 years later (Hall, 2006). Furthermore, every president of the United States has been taller than the national average height, with the exception of one 106 years ago who was 5'7". It's hard to argue that being taller genetically primes you to be successful, rather height is seemingly associated with social and cultural norms that reinforce one's success based on others perceiving them differently.

If others see us a certain way based on height, it then prompts us to act a certain way, and our perceived physical height becomes associated with our internal states of perceived power and control. Since anxiety is a perceived loss of control in the face of a threat, it can be postulated that high anxiety may physically minimize one's self-image. Furthermore, if one sees themselves as smaller under these circumstances, it may attribute to the perception of external stimuli under stress.

Visual Perception

Perception at the neurological level does not always reflect accurate knowledge of our own body, let alone what is in our immediate environment. For example, conflicting visual-somatosensory input in a virtual reality paradigm causes people to separate themselves from their body and mislocalize themselves towards a virtual body (Blanke, Lenggenhager, Metzinger, & Tadi, 2007). In other words experiments can actually induce a state similar to an out of body experience, during which one does not perceive the environment from their physical body. Our

understanding of ourselves is so highly based on our environment that sometimes, as in the case of a virtual reality paradigm, we cannot even decipher our own body from another (Blanke, Lenggenhager, Metzinger, & Tadi, 2007).

In order to understand how internal states influence one's perception of external spatial stimuli, a reliable method of spatial estimates must be established. Before this can be determined, first an understanding of visual processing must be explored. The perception of spatial stimuli relies on the combination of the angle of vergence and binocular disparity, which is the difference between the perceptions of the visual field from each eye (Foley, 1980). However, these are just the basic mechanisms and they alone cannot explain vision. There is an additional sensory influence that organizes information from a top-down approach. Meaning in order to perceive most visual scenes we fill in missing information with our mind, mostly through the use of an area in the cerebral cortex (Foley, 1980). Alternatives to this theory are nativism, which explains perception as intuitive, and empiricism, which explains perception as a synthesis of past experiences.

A further hypothesis with neurological support is the two visual systems hypothesis, which explains the processing of visual information based on two different visual pathways (Andre & Rogers, 2006). One pathway is the dorsal stream, which is the "where" involved with spatial attention and guiding behavior to spatial locations, and the other is the ventral stream, which is the "what" stream and deals with recognizing, identifying, and categorizing stimuli. Damage to the dorsal stream leads to an inability to correctly pick up stimuli in the visual field, and damage to the ventral stream leads to prosopagnosia, which is characterized by the inability to recognize faces, even when one can recognize complex objects.

Verbal reports rely more heavily on the ventral path, as noted by a profound influence of environmental cues on spatial estimation, and blind-walking estimates are more associated with the dorsal path, as influenced by the position of the visual field on sight (Andre & Rogers, 2006). Verbal reports of visual estimates rely on the ventral pathway for perceptual awareness, as this is a conscious process that works with top-down processes of perception. Therefore verbal estimates, though not as accurate as blind-walking estimates, may be most accurate in reporting one's perception of the environment rather than the actual environment. Other distance measures on the other hand, such as walking based judgments, may use an action-oriented pathway that deals more with fight or flight reflexes at a subconscious level. Overall, there are three main ways of estimating distance: Verbal or written estimates, blind-walking estimates, and simulation estimations (Andre & Rogers, 2006).

Simulation estimates are generally more accurate than verbal or written estimates. For example, conscious awareness of the slant of a hill is typically overestimated, but visually guided actions directed at hills are relatively accurate. So the explicit awareness of slant is influenced by the fear associated with a potentially dangerous action, and therefore when looking at what variables influence the awareness of spatial cues, explicit estimates of space may be the most valuable since they have more perceptual input (Clore, Proffitt, & Stefanucci, 2005). Verbal estimates are influenced by cognitive factors and response biases (Foley, 1980). Regardless of the means of estimating distance, distance estimates are consistently overestimated, however this may be due to whether the estimate itself is emphasized or if its part of another, action oriented task, in which case it is more accurate (Heft, 1993).

Estimates of distances to stimuli can be measured in a plethora of ways, but the qualities of the stimuli themselves are relatively constant. Regardless of distance, the shape and size of an

object remains constant. In order to measure stimulus size, one can compare the stimulus at a distance to multiple sizes of stimuli up close, but this is not accurate because it does not follow the law of size constancy and does not accurately measure size perception (Gilinsky, 1951).

In conclusion, the perception of the distance to an object, its perceived size, and the perception of one's own spatial qualities can be measured multiple ways, and verbal or written reports often leave room for the most accurate perception of the stimulus, though not necessarily the most accurate estimates. Furthermore, studies have found that there tends to be a relationship between size and distance estimates, coined the 'size distance paradox'. The paradox is that stimulus that is underestimated in size tends to be overestimated in distance and vice versa (Gruber, 1954).

Current Study

In summary, previous research supports a subconscious link between mind and body. What we think is highly correlated with our response to the physical environment. In individuals with social anxiety disorders, social situations lead to a notion of threat and heightened arousal, often accommodated by a need to escape. This flight instinct should theoretically fall in line with previous research that finds threatening situations, objects, and locations to be perceived differently than physical stimuli that are not charged with a threat. High arousal has been shown to cause a narrowing of attention, more dramatic distance and size estimates, and often correlates with perceiving threatening objects as larger. Threatening people and locations are perceived as closer, and stressful social events feel psychologically closer.

The established link between social threat and altered perception of the spatial environment has only very recently been established (Bave and Xiao, 2012). The connection between individualized threat perception and physical perception has not been explored in

socially stressful situations or extended to social phobias. Furthermore, previous research has failed to look at perceptions of stimulus size and individual's perceptions of themselves in relation to perceptions of the environment. Individuals under perceived power overestimate their height (Duguid & Goncalo, 2012), and anxiety is a perceived loss of control in the presence of a threat. Therefore, individuals under social stress and with social anxiety may alter not only their perceived environment, but also their perceived self, in order to cope with threatening social stimuli. Finally, if the spatial environment is perceived differently under a paradigm of threat, a measure of perceived height can serve to clarify whether it is due to the external threat and the need to respond to the environment, or if it is a psychological process by which the threat makes one feel smaller and therefore perceive the spatial qualities of the environment differently accordingly.

Internal states and perception of the external world are not always fully dissociable in the subconscious mind, and therefore inducing psychosocial stress should alter the perception of stressful stimuli, particularly for people with social anxiety. This is important to study because individuals with social anxiety may actually physically perceive their environment differently, particularly under social stress, and therefore it is important to find these differences if they exist. If differences do exist then the next step will be to understand why there are these subconscious influences on spatial perception and how they can be used to help individuals with anxiety.

The current study will use a variation of the TSST to induce social stress in participants. Participants will either focus on the lens of a video camera while doing multiple stressful social tasks, or be in a control condition in which there is no social stress. Social anxiety and social stress, as measured by a survey, will be looked at as predictors of spatial estimates. In line with

previous research, spatial estimates will be written using both number estimates and scale estimates.

I hypothesize that when in an environment with social stress, participants with higher social anxiety will perceive the video camera as closest and largest, participants in the control condition with low social anxiety with see it as furthest and smallest, and high social anxiety in the control condition and low social anxiety in the stress condition will have estimates in between. This is hypothesized to occur because under social stress and social anxiety, the video camera should be associated with social threat, and therefore trigger adaptive perceptual changes. Seeing the stimulus as closer and larger is an evolutionarily adaptive quality because it allows the individual to react faster to the threat, but it also falls in line with the economy of action theory. If one feels emotionally drained from stress and anxiety, then the mind may subconsciously bring a stimulus closer to charge the individual to cope in the socially stressful situation and this is an adaptive advantage.

I further hypothesize that socially anxious and stressed participants will estimate themselves as shorter, and the control condition will perceive their own height more accurately. This should be the case because if these individuals see the stimulus as closer and larger, then it might be because they also perceive themselves as shorter, since being shorter in our culture is associated with a perceived lack of power, lack of authority, and failure.

Method

Participants

Participants were psychology students recruited through the SONA System at the College of Wooster for one course credit. There were 53 participants, 26 in the stress condition and 27 in the control condition. There were 18 males and 35 females, and all participants confirmed

normal or corrected vision at the time of testing; 31 had normal vision, 17 wore contacts, and 4 wore glasses.

Materials

TSST (Trier Social Stress Test). The TSST is an established test for eliciting stress (Hellhammer, Kirschbaum, & Pirke, 1993). Participants stand at a podium in front of a recording video camera and a one-way mirror, and participants are asked to focus on the video camera throughout the tasks. In order to prompt an evaluative self-focus, subjects deliver a speech in front of a one-way mirror and are told that a panel of judges are behind the mirror, evaluating their performance (Britton, Jacobs, Shahar, & Szepsenwol, 2012). The speech is made in front of a microphone on a podium, in the presence of a video camera. Participants are told that their performance is being recorded for later analyses, even though the video camera is not actually recording them.

Four voices, two male and two female, were recorded ahead of time and used to give instructions and feedback during the task. Recordings were edited and standardized using recording software. Recordings were used because the performance in TSST hinges on group evaluation in order to maximize stress, but using confederates increases the potential for variation among participants and recordings are more standardized.

First, a recorded voice through a loud speaker requires that participants give a 5-minute speech. Whenever the subject finishes the speech in less than five minutes, a second recorded voice responds ‘You still have some time left. Please continue!’, the second time the participant pauses for at least 20 seconds, the recorded voice will ask again that the participant continues. A third voice gives instructions for completing a difficult math problem, which is to subtract the number 13 from 2083 in increments, as fast as possible. Whenever the participant makes an error

the final recorded voice responds “Error, please start from 2083 again”, and the participant is stopped after 3 minutes. Based on analyses conducted by Hellhammer, Kirschbaum, and Pirke (1993), this stress test causes an immediate peak in ACTH, prolactum, serum, and a 2 to 4-fold increase in salivary cortisol, all of which reach their peak after 10 minutes. Therefore, it is not necessary to take physiological measures during this test due to the high test retest reliability of increased cortisol and self rated stress.

Survey. (See appendix A) Participants complete the survey while standing at a podium 14 feet in front of a video camera set up on a tripod. Part I of the survey consists of a few questions that tap into spatial perception. Participants are instructed to write an estimate of the perceived distance between themselves and the camera in feet, given that the survey page is 11 inches, almost one foot. They then are asked how close they feel to the camera on a 1 to 7 scale, lower numbers indicating that the camera feels closer and higher numbers indicating that the camera feels further. A similar estimate is asked for the size of the camera, from 1 to 7, 1 being small and 7 being large. Then they are told to close their eyes and visualize their height at which point they look at a height scale, also 14 feet away, with vertical lines labeled A-M, and record the letter that matches the line that they believe to be their height. Their actual height is measured up against the vertical lined scale later.

Part II of the survey consists of seven statements about perceived state anxiety based on the shortened Spielberger State-Trait Anxiety Inventory (STAI) (Bekker & Marteau, 1992). Statements are responded to on a scale of 1 to 4, with 1 meaning not at all, 2 meaning somewhat, 3 meaning moderately, and 4 meaning very much. Participants are asked to circle the number that most indicated how they felt at the current moment. Example statements are “I feel calm” and “I feel upset”. The shortened Spielberger State-Trait Anxiety Inventory Correlation has

indicated good reliability with a Cronbach's alpha of .81 and concurrent validity with correlation coefficients greater than .90 compared to the longer 24-item STAI as found by Bekker and Marteau (1992). Researchers have not looked at test-retest validity as the scale measures short-term anxiety, which is expected to fluctuate.

Part III consists of six statements that assess generalized trait social anxiety based on the shortened social interaction anxiety scale (SIAS) (Andrews, Mattich, Peters, Rapee, & Sunderland, 2011). Directions are to rate statements on a scale of 0 to 4, with 0 indicating not at all characteristic or true of me, 1 slightly characteristic or true of me, 2 moderately characteristic or true of me, 3 very characteristic or true of me, and 4 extremely characteristic or true of me. The statements are all characteristic of social anxiety, for example "I have difficulty making eye contact with others" or "I find it difficult to disagree with another's point of view". For analyses, items were analyzed individually, as well as a composite score of 0 to 24, which indicated their overall trait anxiety. According to Andrews et al. (2011), the shortened SIAS exhibits high internal consistency with a Cronbach's alpha value of .90, high test-retest reliability, $r > .91$, and discriminant and construct validity. Finally, Andrews et al. (2011) computed adequate concurrent validity as indicated by strong positive correlations with the Brief Fear of Negative Evaluation (bFNE) and Depression Anxiety Stress Scales (DASS-21).

Procedure

Participants were told that they would be doing a study on spatial understanding, but were not informed about the overall intentions of the experiment beforehand. Informed consent was administered before starting the study. Participants were randomly assigned to one of two conditions: Stress or control. In the stress condition, participants completed the TSST task while being informed to focus on the video camera and while giving a speech and mentally calculating

math problems. Then participants completed the survey. In the control condition participants again stood at the podium in front of the video camera, but it was not on and they did not perform any tasks and only completed the survey. In both groups participants were facing a one-way mirror. At the end of the study, all participants had their actual heights measured by putting their backs to the A-M height measure, and they were finally fully debriefed.

Results

Of the 53 participants, one participant's data was removed for being 3 standard deviations above the mean for the estimation of video camera size, which had a mean of 3.91 (SD = 1.10) prior to the removal of a data point (7) and a mean of 3.84 (SD = 1.02) post removal. Therefore, 52 participants were used in the following analyses.

The actual distance between the podium and the video camera was 14 feet. The average estimate to the video camera was 11 feet (SD = 2.96). To test that there was a bias towards estimating the video camera as closer than it actually was among the entire participant pool, a single sample t-test was conducted. Analyses indicated a significant difference between the actual distance in feet to the video camera and the estimated distance to the camera in feet, t (51) = -6.93, $p < .001$. Participants estimated the video camera at an average distance of 11.16 feet away (SD = 2.6), which is significantly closer than the actual distance of 14 feet.

The average participant height was 67.23 inches, or 5'6" (SD = 3.92), and the average estimated height was 68 inches, or 5'7" (SD = 5.60). To test whether or not people overestimated their height, a paired sample t-test was conducted. There was not a significant difference between the real height and estimated heights, t (52) = 1.40, p = .17. This indicates that while there was a minor trend to overestimate height, this trend was not significant.

The average stress rating, as measured from 1 (less stressed) to 4 (more stressed), was 2.26

(SD = 1.02). The mean trait social anxiety score was 6.81 (SD = 4.37), from a scale of 0 (no social anxiety) to 24 (severe social anxiety), and scores ranged from 0 to 18, inclusive. According to Andrews, Mattick, Peters, Rapee, and Sunderland (2011), the optimum cutoff score for a diagnosis of social phobia is 7 or higher. According to this cutoff for the shortened SIAS assessment, 53.8% of participants did not have social phobia and 46.2% met the criteria for social phobia.

In order to determine whether the TSST actually caused stress, the effect of stress condition and gender on stress and anxiety was studied through a MANOVA. As indicated in table 1, there was a significant main effect of stress condition on reported values for short-term feelings of being calm, tense, relaxed, content, and stressed. Participants in the stress condition were significantly less calm, relaxed, and content, and more tense and stressed than the control condition. The overall model indicates that short-term anxiety was significantly different between conditions, F (1, 48) = 10.72, $p < .002$. Trait social anxiety, as measured by the SIAS, did not significantly differ between the stress group and the control group, F (1, 48) = .001, p = .98, which was expected as trait anxiety should not fluctuate in short-term circumstances.

Table 1

MANOVA Predicting subsets of stress from control and stress conditions

	Condition					
	Stress		Control			
Dependent Variable	M	SD	M	SD	F	DF
Calm	1.88	.83	2.96	1.01	18.74***	1, 48
Relaxed	1.72	.84	2.74	.86	19.64***	1, 48
Content	2.12	1.05	2.74	.86	5.55*	1, 48
Tense	2.76	1.01	1.93	.87	8.49**	1, 48
Stressed	2.60	1.04	1.94	.90	4.91*	1, 48

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$

In order to determine whether there was an effect of stress condition and gender on the spatial estimates including perceived height, distance in feet to the video camera, perceived distance to camera on a scale, and perceived camera size, a MANOVA was conducted. There was a main effect approaching significance of stress on perceived distance, F (1, 48) = 2.98, p = .09. This indicates that individuals in the stress condition (M = 4.16, SD = .99) perceived the video camera as further than the control group (M = 3.81, SD = .96). There was also a main effect approaching significance of stress on camera size, F (1, 48) = 3.33, p = .07, by which the stress condition (M = 3.70, SD = .95) perceived the camera as smaller than the control condition (M = 4.0, SD = 1.07). This indicates that stress has a marginal influence on the judgments of distance and camera size. Finally, there was an effect of gender on perceived distance to the video camera in feet, F (1, 48) = 4.07, p = .05, by which females estimate it as closer (M = 10.60, SD = 2.62) than males (M = 12.25, SD = 3.31). There were no interactions between gender and stress on spatial estimates. There was no effect of stress on perceived distance to the video camera. There was also no effect of stress on perceived height, indicating that the hypothesis that stressed participants will estimate themselves as shorter than the control condition is not supported.

In order to test that qualities of social anxiety are related to spatial perception, Pearson-product moment correlation coefficients were conducted between spatial perception judgments and all other variables, and multiple significant correlations resulted for perceived camera size, perceived distance to the video camera, and height estimates. These correlations are presented in table 2, and discussed in the following paragraphs.

Table 2

Correlation Matrix for Anxiety, Stress, and Spatial Estimates

Independent Variable	Camera Size	Distance (ft)	Distance Scale	Height
Social Anxiety Scale	.28*	-.18	.14	-.033
Difficult Mixing with Others	.15	-.25†	.06	-.1
Difficult Disagreeing	.19	-.30*	.02	.09
Tense Around Acquaintances	.40***	.003	.08	.02
Worried	.26†	-.06	-.07	-.09
Content	-.26†	.004	-.05	.03
Upset	.08	-.08	.04	-.28*
Gender	-.11	-.27*	.11	.03
Stress	.24†	-.13	.02	-.16

† $p \leq .1$. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$

There was a significant correlation between perceived camera size and the entire social anxiety scale, r (52) = .24, p = .05, indicating that higher social anxiety is related to perceiving the video camera as larger. The social anxiety scale can further be broken down into the subset questions for a more thorough analysis of correlations. There was a significant relationship between feeling generally tense around acquaintances and the perceived size of the camera, r (52) = .39, p = .004. This is a positive relationship indicating that participants who feel more tense around acquaintances, a subset of the social anxiety scale, perceived the camera as larger than those who feel less tense around acquaintances. There was a positive correlation approaching significance between feeling worried, a subset of current stress, and the perceived size of the camera, r (52) = .26, p = .07. This indicates that feeling more worried is associated with perceiving the video camera size larger. Furthermore, there was a positive correlation approaching significance between feeling currently tense, a subset of state anxiety, and the perceived size of the camera, r (52) = .23, p = .09. This indicates that feeling short-term tenseness is associated with increased perceived video camera size. Overall, this indicates that there is a trend for seeing the video camera as larger when socially anxious, particularly due to

being worried and tense around acquaintances, and seeing the video camera as smaller when content. Furthermore, feeling currently tense, an aspect of state anxiety, corresponds with seeing the video camera as larger.

There were also multiple correlations between the perceived distance to the video camera in feet and anxiety measures. There was a significant negative correlation between having a difficult time disagreeing with others and the perceived distance to the video camera, r (52) = -.30, p = .03. This indicates that individuals who have a difficult time disagreeing with others perceived the video camera as closer. There was a negative correlation approaching significance between having a difficult time mixing with others and the perceived distance to the video camera, r (52) = -.25, p = .08. This means that participants who have a difficult time mixing with others perceived the video camera as closer. Based on analyses from an independent samples t-test, there was a significant difference between males and females in the perceived distance to the video camera in feet, t (50) = 1.99, p = .05. Females (M = 10.57, SD = 2.62) perceived the video camera as closer than males (M = 12.25, SD = 3.32). Overall, the correlations indicate a trend for seeing the video camera as closer when female, when having a difficult time disagreeing, and when it's hard for to mix with others.

There was a negative correlation between the difference between the actual and estimated height and currently feeling upset, t (52) = -.28, p = .04. This indicates that participants who were upset estimated their heights as shorter than their actual heights and the less upset participants were, the taller they estimated their heights to be.

In order to test the hypothesis that when in an environment with social stress, participants with higher social anxiety will perceive the video camera as closer and see it as larger than when in the control condition, an interaction effect was analyzed between stress condition and anxiety

scores. For the purpose of this analysis, anxiety was dichotomized into either anxious, as indicative of a score of 7 or over, or not anxious, which is categorized by a score less than 7. A Multivariate ANOVA was conducted with stress and anxiety as fixed factors and the dependent variables being camera size, estimated height, estimated distance in feet, and perceived distance on a scale. The overall MANOVA was not significant for perceived distance, F (3, 48) = 1.50, p = .23, perceived distance in feet, F (3, 48) = .96, p = .42, perceived video camera size, F (3, 48) = 1.82, p = .16, and perceived height, F (3, 48) = .26, p = .87. The only significant trend was a positive effect of social anxiety on video camera size, F (1, 48) = 4.05, $p < .05$. There were no other effects of stress or anxiety on spatial estimates, and no interaction between stress condition and anxiety on spatial estimates. Therefore, the hypothesis that when in an environment with social stress, participants with higher social anxiety will perceive the video camera as closer and see it as larger than when in the control condition, was not supported.

Since there was a significant effect of social anxiety on camera size, aspects of social anxiety were further studied in multiple linear regressions. Multiple regressions were conducted predicting spatial estimates (distance, size, and height) from anxiety and stress subsets. Results indicated that none of the components from the shortened Spielberger State-Trait Anxiety Inventory (STAI) predicted spatial estimates. However, some statements that assessed generalized social anxiety based on the shortened social interaction anxiety scale (SIAS) did significantly predict spatial estimates, and those regressions are presented.

A significant linear regression predicted camera size from the SIAS. There was a significant effect of social anxiety on perceived camera size, B = 3.41, t (48.77) = 13.37, $p < .05$. R^2= .08, indicating that 8% of the variability in camera size can be explained by trait social anxiety. This relationship is indicated in figure 1. The higher one's social anxiety, the larger they

perceived the video camera. Furthermore, if we use the cut-off at 7 for social anxiety as advised by Andrews, Mattick, Peters, Rapee, and Sunderland (2011), the camera size estimates are marginally significantly different, as indicated by an independent sample t-test, t (50) = 1.90, p = .06. People who reach the cut-off for social anxiety see the video camera as larger (M = 4.13, SD = .90) than people who do not have social anxiety (M = 3.61, SD = 1.07).

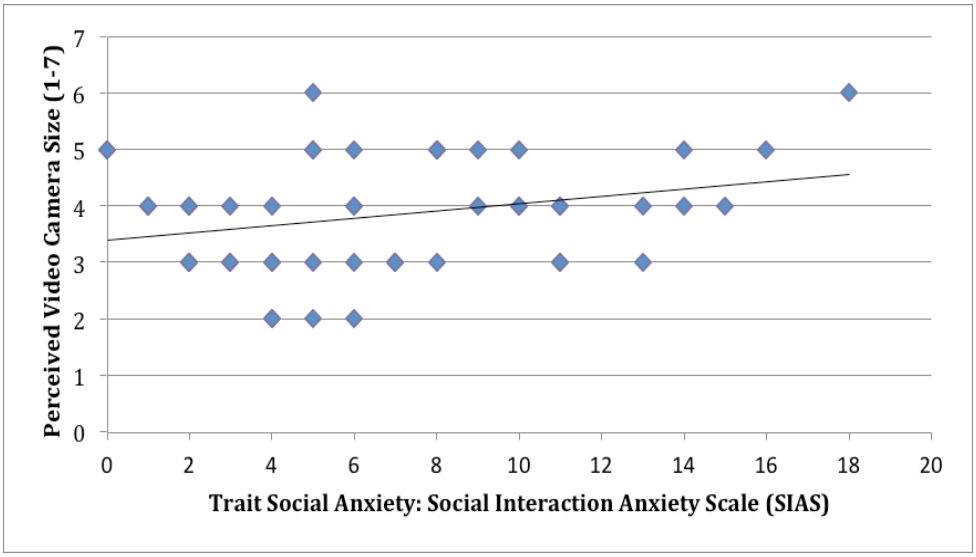

Figure 1. Social anxiety as a significant predictor of the perceived size of a threatening social stimulus.

A linear regression predicted camera size from tense around acquaintances, tense alone, and difficulty mixing with others. Individually, there was a significant effect of tense around acquaintances on approximated distance, B = .47, t (48) = 2.73, p = .008, no significant effect of tense alone on approximated distance, B = -.13, t (48) = -.77, p = .42, and no significant effect of difficult talking on approximated distance, B = -.13, t (48) = -.62, p = .54. Finally, there was a significant interaction between tense from acquaintances, tense alone, and difficult talking on perceived camera size, F = 3.16, p = .03. R^2= .17, indicating that 17% of the variability in camera size estimates can be explained by the previous predictor variables.

A linear regression predicted distance in feet from the interaction between difficulty

disagreeing, tense from acquaintances, difficulty mixing, and gender. Individually, there was not a significant effect of gender on approximated distance**,** B = -1.22, t (47) = -1.48, p = .15, difficulty mixing on approximated distance, B = -.81, t (47) = -1.82, p = .08, and tense from acquaintances on approximated distance, B = .65, t (47) = 1.48, p = .15. There was a significant effect of difficulty disagreeing on approximated distance, B = -.79, t (47) = -2.043, p = .05. Finally, there was a significant interaction between gender, difficulty disagreeing, difficulty mixing, and tense from acquaintances on approximated distance, F = 3.04, p = .03. R^2= .21, indicating that 21% of the variability in estimated distance in feet can be explained by the four predictor variables.

Discussion

Results indicate that the Trier Social Stress Test did cause more self-reported stress in participants, but participants in the stress group did not have any major differences in spatial perception of the stimulus from the control group. Therefore the hypothesis that when in an environment with social stress, participants will perceive themselves as shorter and the video camera as closer and larger than when in the control condition, is not supported. There were, however, correlations across the stress and non-stress groups between anxiety and stress subsets and spatial estimates. Furthermore, there were significant regressions that indicated that certain anxiety and stress states predict certain spatial estimates. In particular, trait social anxiety, regardless of stress condition, was a predictor of camera size, subsets of the social anxiety scale predicted distance to the video camera, and being upset predicted height estimation. For people with social anxiety, giving a speech is known to trigger anxiety (Denollet & Kupper, 2012). The results indicate that acute stressors, in this case the stressful social task, do increase short-term stress and trigger anxiety. However, regardless of whether participants had their anxiety

triggered, there were certain aspects of anxiety and stress states that corresponded with their perception of the environment.

In-Depth Analysis of Social Anxiety on Spatial Perception

Results indicate an overall trend for social anxiety consistently correlating with perceiving threatening stimulus as closer and larger, and neutral or positive states correlating with the perception of stimulus being further away and smaller. Before the implications of this are discussed, I will go into depth about reasons behind why the specific social anxiety factors corresponded with the perception of different stimulus features, including distance, size, and even one's own height.

The size of the video camera was estimated on a scale for how large participants felt the camera appeared to be. In the entire sample, there was no bias for video camera size. But based on correlations, there was a trend for seeing the video camera as larger when worried, having social anxiety, being tense around others at a trait and state level, and seeing the camera as smaller when content. The social anxiety scale accounted for 8% of the variance in video camera size estimates. The indication here is that higher social anxiety predicts seeing the video camera as larger. This relationship is not influenced by stress. The specific subsets of social anxiety that were most significant for this prediction were being worried, tensing around acquaintances, and being less content. This is aligned with the proposed hypothesis that social anxiety increases the threat of the video camera and in turn increases its size in order to prepare one to react.

There are a few theories that help to explain this bias. First, according to an evolutionary perspective, if a stimulus is threatening or associated with a threat it is typically seen as larger in order to prepare one to react. In this case, the video camera is a threat for individuals, particularly those with social anxiety, and therefore it may be seen as larger by individuals high in social

anxiety in order to help prepare them to react appropriately. The video camera is a signal of social-evaluation and self-evaluation and therefore from an evolutionary perspective it carries the pressures of group cohesion. Biologically, being strongly connected to one's group enhances survival. Social anxiety influences one's belonging to a group, and the video camera symbolizes this struggle, which triggers anxiety. Based on this theory, the video camera triggers anxiety in individuals who have social anxiety based on a long enduring trend, and therefore current stress or anxiety should not have as strong an influence on the perception of the video camera.

Building off of the prior hypothesis, another explanation is that individuals with social anxiety load the video camera with negative information, whereas individuals that do not have social anxiety associate the video camera with neutral or positive connotations. Beek, Oudejans, Semin, and van Ulzen (2008) loaded positive or negative information onto the surrounding circles of the Ebbinghaus illusion, and discovered that regardless of whether the circles were embedded in larger or smaller circles, the negatively loaded stimuli were seen as significantly larger than the positively loaded targets, as they needed to be attended to more quickly. This falls in line with evolutionary theories that posit that negative stimuli need to be attended to more quickly than positive stimuli since they are more adaptive to avoiding danger than approaching positive stimuli. Therefore stimuli may be perceived as larger to trigger this adaptive response in the presence of a threat.

This hypothesis also brings up a potential covariate that was not accounted for. The stress task had differential reactions in participants. Some people did better than others at the tasks, which may have triggered either a negative or positive self-evaluation, depending on one's abilities and knowledge of the topic and math problems. Though there was no feedback given by the researcher, participants could easily gauge their own abilities. This brings up the issue that

the stress and mirror triggered an evaluative focus and it would have been valuable to measure efficacy and self-esteem under these settings, as they could serve as significant mediators or predictor variables (Stefanucci & Storbeck, 2009). Ideally, appraisal should be distinguishable based on social anxiety. According to Clark and Wells (1995), a defining feature of social anxiety from a cognitive perspective is the attentional bias towards negative stimuli in order to attend to a negative self-fulfilling prophecy. However, skill and achievement on the tasks still vary in socially anxious individuals.

When breaking down trait social anxiety by its subsets, being tense from acquaintances was the largest correlation, and in regression analyses, accounted for 15% of the variance in camera size. "I tense up if I meet an acquaintance on the street" is the exact item. This correlation with camera size is an interesting one because this scale item relates most highly to the physical response of anxiety. If one physically tenses around acquaintances on the street, then in an experimental setting, regardless of whether they complete a stress test or are alone with a researcher who is an acquaintance or stranger, they are likely to be tense. This tense response of anxiety triggers a response to be alert and respond to distressing stimuli, so the video camera, which is the stimulus that they are instructed to hone their attention on, is seen as larger.

Tensing up is furthermore a signal of fear. Fear attributes to the cost of action, by which fear triggers a reaction, and perceptual biases may be a guide to enhance the reaction. For example, under fear of great heights, stimulus on the ground is perceived as both closer and larger, which supports one's ability to react to the situation (Steffanucci & Storbick, 2009). In this case, one sees the video camera as larger when one is tense because being tense decreases one's ability to act, and therefore sensory perception kicks in to help reactions by increasing the size of the video camera so that it can be better attended to.

The perception of the distance to the video camera was measured both by how close participants felt to the video camera on a scale, and also by an estimate in feet. Based on the estimate in feet, there is a trend for seeing the video camera as closer when the participant is female, when the participant has a difficult time disagreeing, and when it's difficult to mix with others. Only the first two correlations were significant, and the third was only approaching significance. Those having a difficult time disagreeing may see the stimulus as closer in order to help prepare for action. If one has difficulty saying no, then at a social level they are not prepared to deal adequately with social threats so bringing the video camera closer may allow them to prepare how to respond to the social situation.

Differential Effects of Social Anxiety and Stress on Spatial Estimates

All in all, analyses concerning social anxiety predicted seeing the video camera as larger and correlated with perceiving it as closer. However, analyses of stress condition based on an ANOVA predicted seeing the video camera as further away and smaller. Though seemingly contradictory, this is logical because stress and social anxiety play significantly different roles in perception.

Stress has an adaptive response for spatial learning, such that higher stress increases simple stimulus response strategies due to limited attentional resources and less spatial strategies that require cognitive ability (Bohringer et al., 2007). A stress loaded stimulus is negative and therefore it is beneficial for one to push it away. For example, when Balcetis and Dunning (2010) gave negative false feedback on an assessment, participants perceived the assessment to be further away than when it contained positive feedback. Negative stimulus is not always advantageous to see as closer, and therefore an adaptive response under cognitive simplification may be to avoid the stimulus.

However, when the stimulus is indicative of a threat to social anxiety, it is advantageous to see it as closer as confronting the stimulus is beneficial. This is because social anxiety is defined by conflicting approach-avoid motives. A socially anxious individual experiences fear in social situations, and this is at least in part due to a fear of failure or rejection (Papsdorf & Alden, 1998). Escaping from the video camera would increase rejection further, so seeing it as further would increase the potential for rejection. Therefore it would be better to approach the stimulus, and see it as closer. Furthermore, in an approach-avoid conflict, anxiety can function to bring one closer to the threat due to coping mechanisms (Mineka & Öhman, 2001). In anxiety disorders many coping mechanisms are typically overwhelmed or lacking, so instead of using traditional coping mechanisms, perception may step in as an alternate coping mechanism.

Another important distinction is that only the stress condition, and not stress ratings, predicted seeing the video camera as closer. In the stress condition the video camera was on and appeared to be recording the participants, which participants could see in the reflection of the two-way mirror, whereas in the control condition the video camera was off in order to eliminate stressful connotations. The functioning video camera may have influenced participants to distance themselves from it, particularly in a stressful setting, because it may have induced a negative self-evaluation that caused participants to mentally distance themselves from it. Secondly, in the stress condition the experimenter was behind the two-way mirror so the participant was alone in the room while making distance estimates whereas in the control group the experimenter was in the room. Since this was not controlled across groups, this creates another limitation and potential covariate by which a presence in the room may have altered spatial perception.

The discrepancy here may be further analyzed through the framework of two hypotheses

of spatial perception: The positivity-closeness hypothesis and the functionally adaptive hypothesis. According to the positivity-closeness hypothesis, desirable stimuli are perceived as closer due to agreeable contexts and undesirable stimuli are perceived as farther because they are disagreeable and therefore cause the individual to wish the stimuli further away to the extent that the stimuli is actually perceived as further. According to this lens, facets of social anxiety may cause one to perceive the video camera as close because there is a desirability associated with it in that it may symbolize a chief goal: Socialization and acceptance. Stress is undesirable and therefore may cause one to perceive the video camera as further away.

The second contradicting hypothesis posits that it may be functionally adaptive to represent potentially threatening stimuli as closer than they actually are in order to trigger adaptive behavior (Alter & Balcetis, 2010). If one vividly perceives threatening stimuli as closer, that may give the individual the energy to deal with the stimuli. Again, this supports the view that social anxiety promotes social activity by encouraging contact with social stimulus by bringing it closer at a perceptual level.

There was no interaction between anxiety and stress in spatial estimates as hypothesized. Neurological pathways in the amygdala that distinguish between the conscious and unconscious processing of stimuli indicate that when the perception of stressful stimuli or threats is unconscious, social anxiety mediates stress due to the activation of the basolateral subregion of the amygdala, but when conscious it is not affected by social anxiety (Dudman et al., 2004). Therefore the lack of an interaction may have been due to the methodology, which based distance estimates to the video camera on a conscious effort. Future studies may choose to use an implicit perceptual task to look at the interaction of stress and social anxiety on spatial perception.

Applicable Theories and Alternate Explanations

In terms of social anxiety, all of the significant correlations and correlations approaching significance followed the same pattern by which higher ratings in anxiety corresponded with perceiving the video camera as closer and larger, and higher ratings in positive subsets corresponded with seeing the video camera as smaller and further away. However, that so many of these correlations were only approaching significance indicates that there are likely other variables influencing perception, which have not been accounted for. According to Bave and Xiao (2012), social categorization, collective identification, and identity threat work together to influence perceptions of threats in the physical world. Threatening groups are perceived as physically closer, especially when one's identification with the in-group is greater. Therefore, it is very possible that in addition to the threat of the video camera and social anxiety, variables dealing with identity may have played a role in spatial perception in the current study. Furthermore, Epstein, Proffitt, and Witt (2004) found that perceived distance is highly influenced by effort and intent, which are variables that should also be controlled in future studies.

Results indicate a trend for high scores on social anxiety subsets correlating with perceiving the socially stressful stimulus, the video camera, as closer. A typical explanation is that this occurs due to the narrowing of attention associated with arousal (Kitayama & Niedenthal, 1994). Arousal tends to be higher under stress and negative affect, and therefore one might hypothesize that the video camera may have been perceived as larger under social anxiety since it is perceived as a negative stimulus and therefore increases arousal, which would cause a need to respond more quickly. This furthermore guides attention to the source, and it ultimately feels larger. However, the TSST is known to increase arousal, as indicated by a 2 to 4-fold increase in salivary cortisol (Hellhammer, Kirschbaum, & Pirke, 1993). Since there were

minimal differences in spatial estimates between participants that did this task and those who did not and the differences were in the opposite direction than suggested by the literature, it is highly unlikely that arousal influenced perception to any significant degree. It is possible that the arousal associated with social anxiety exceeded the arousal of the social stress test, in which case it could explain results, but this is highly unlikely.

Ruling out arousal as the predominant reason for the trends in perception, a good explanation for the findings falls in line with the New Look approach to perception. According to the New Look philosophy, biased perception is the organized visual representation of the world resulting from individualized values and needs (Bruner, 1992). When an individual has higher anxiety, it triggers the need to respond to the stressor, which in this study was the video camera. When the individual is driven to see the video camera as closer and larger, it can be more quickly reacted to. These results fall in line with much of the resent research done on threats, stress, and spatial perception. The latest published research in this field was that New York Yankees fans estimated the distance to Fenway Park, the stadium of a threatening out-group to be closer than did non-Yankees fans, indicating a bias for attending to threatening stimuli more readily than unthreatening stimuli (Bave & Xiao, 2012).

Unlike previous studies, the current study did not look at a threat to one's group, but to one's individual identity. This distinction is key, as in this study the two-way mirror provided a strong self-evaluative focus. This focus may have triggered a perceptual bias that is self-protective. Support for the negative self-evaluative focus in individuals with high anxiety lies in a study conducted by Clark and Mansell (1999), by which people were given a list of trait words and then told they would have to give a speech. High socially anxious individuals remembered less positive self-referent words, and underestimated their performance and overestimated their

anxiety after giving the speech than low anxious individuals. If one has social anxiety, a disorder highly correlated with low self-esteem which is the core issue in social and performance anxiety (Leary, 1990), then socially anxious individuals in a self-evaluative situation may associate the video camera as not only a social threat, but a threat to one's identity.

Bave and Xiao (2012) coined the perceptual bias in their study as "seeing your friends close and your enemies closer". In the current study, this enemy may symbolize one's anxiety. Participants may have intuitively envisioned the video camera as closer and larger in order to keep the threat of the self-evaluative stimulus in reach so that it can be highly attended to, and reduce anxiety. This threat would be higher in certain anxiety subsets, such as having a difficult time disagreeing with others, which in turn would correspond to a greater need for attending to the stimulus.

Perception of Height

It is important to note that self-perception of height had no relation to anxiety as a whole, but being upset did correlate with perceiving one's height as shorter. Previous research has indicated that people are good at estimating their own height, but motivational factors can influence perceptions of height. For example, greater perceived power causes one to overestimate their physical height (Duguid & Goncalo, 2012). In this study, being upset only motivated one's perception of one's own height, but not of the perception of stimulus in the environment. This may be because anger is an emotion that is more internalized and connected to one's body, whereas anxiety may be more focused on the external environment.

If anxiety influences perception of the environment, but not perception of the self, skewed perception may be due to economy of action, which only involves the environment. This may mean that people who are anxious feel that threatening social stimuli are closer and larger due to

the need to react quickly and it may have nothing to do with how they perceive themselves. Alternatively, it may have been that the height measure was not reliable because there were lots of spatial cues around the room that participants could have used to estimate their height, such as the height of the door or using their reflection in the two-way mirror as a reference.

Implications for Treatment and Future Research

Results indicate a trend for trait anxiety to correlate more with spatial perception than transient anxiety states. This may be a result of one's implicit cognition, which can be a powerful influence on one's perception. If implicit cognition is an unconscious judgment resulting from past experiences, then components of social anxiety such as negative memories of social situations, repeated fears, and low self-esteem may manifest in the unconscious processing of the video camera (Chun & Jiang, 1998). In a sense, it may be that individuals with social anxiety are subliminally primed towards stimuli that evoke feelings of social anxiety, leading to a skewed visual perception of such objects. If this is the case, this same process of implicit cognition can be used to decrease anxiety in therapy. Individuals with social anxiety can learn to pair threatening social cues with positive feedback (Clerkin & Teachman, 2010), and since the mechanisms behind anxiety disorders are so hard to bring to consciousness, the subconscious perceived spatial components of the stimulus could be recorded as a potential source of monitoring progress.

Similarly, an embodied approach method can be implemented to increase approach motives. If an individual is socially distressed, the act of literally taking one step towards a crowd of people may be enough to trigger approach instincts at a psychological, not just physical, level (Eastwick & Finkel, 2009). The results of this study indicate a trend for socially anxious individuals to see threatening stimuli as closer and larger, indicating heightened

awareness and attendance to the stimuli. It therefore may benefit for therapists to encourage socially anxious clients to interact with socially threatening stimuli to increase approach tendencies. Furthermore, since the perceptual spatial bias is implicit, it may be beneficial to bring the bias to conscious awareness as a way of decreasing its threat.

Finally, if we see the mind body connection as a reciprocal process, therapy can tap into the psychological or physical states, or even both, to help decrease anxiety. Moving toward a stimulus increases its likeability, and enhancing positive emotions increases physical approach (Beek & Stins, 2011). Thus, knowing that certain components of anxiety bring threatening stimuli closer at a perceptual level, perhaps people with social anxiety already have an implicit mental model designed to encourage one's approach to the threat. In which case it would be most beneficial to work on physical approach in a therapeutic model.

Since spatial perception is driven by trait anxiety and predispositions to stress, the influence of social anxiety on spatial perception most likely occurs on the basis of enduring pathways. In social anxiety, there may be an internal schema that has been modulated from years of experience that alters one's perception of threatening social stimuli. Wipe someone of these experiences, and this trend would no longer exist because it develops by means of genetic and environmental influences. The enduring effect of state anxiety on spatial perception is substantiated by research that has found that it causes continual atrophy and neuronal death in the hippocampus, which is responsible for spatial mapping (Hahm, Lee, Lee, Park, Yeom, & Yun, 2002).

Previous studies found that small transient moments can alter our perception of the environment, such as feelings of momentary social exclusion reported to feel cold (Bargh & Williams, 2008). The current study expands on this research by extending internal states to traits

that develop over time and consistently influence our perception of the environment. Social anxiety disorder is a long-term disorder that indicates more than just state anxiety. In the current study, the threatening stimulus was seen as larger and closer in correspondence with social anxiety that was stable beyond short-term stressors. The implications for the perception of other stimuli under a variety of internal states and traits are vast, and should be explored in future research.

Future studies may look at individuals with severe social phobias in order to validate these findings and potentially find additional results. In particular, it will provide fruitful to look at the interactions between anxiety disorders and the multitude of disorders that have high comorbidity with anxiety, such as avoidant personality disorder, social phobia, and substance abuse disorders (Chartier, Stein, & Walker, 2003). These disorders were not taken into account in the current study. The results of the current study may also be further extended to other disorders with high comorbidity with anxiety disorders, such as autism, which has an incidence of 1 in 88 people, and is characterized as a developmental disorder paired with social deficits that often lead to social anxiety. Furthermore, Aspergers is known to have many overlaps with social anxiety, and is observed to be associated with a lack of friends, and a driving desire to find one's social place (Antia, Blanco, Liebowitz, & Schneier, 2002). Just this year Adam Lanza, a male hypothesized to have aspergers and reported by others as having severe social anxiety, killed 27 people at his school (Halbfinger, 2012). Social anxiety can clearly have severe ramifications, which is why efficient treatment plans are so critical.

The findings of this study give new support to the reciprocal activity of the body and mind. Through embodied cognition, physical actions influence mental thoughts. Similar to collective unconscious, our thoughts are altered by our interaction with the physical

environment. Likewise, we express ideas, which imprint on our environment, altering our perception. This can be thought of as a cycle by which external stimuli influence internal states, and the new internal state modulates external stimuli, in an endless cycle. The current study is only the beginning to finding just one of those links in a huge series of interactions.

Anxiety disorders need to be attended to for two overarching reasons: They can cause harm to the individual and they may cause harm to others. The results of the current study give insight into the physical correlates of mental anxiety. Mental anxiety may actually warp one's perception of one's physical environment, such that stimuli that have threatening social connotations are perceived as closer and larger. This may in turn heighten the anxiety associated with the threat of these stimuli, and even feed the anxieties if the disorder in not dealt with. The results of the study demonstrate a specific trend for anxiety subsets, tenseness and difficult disagreeing, to increase the perceptual bias. The implications of this research are vast. If we can target these two specific subsets of anxiety in a therapeutic environment, then we may be able to reduce the major components of anxiety and reduce this perceptual bias that may be contributing to anxiety. More research should be done in therapeutic settings to consciously work on the spatial perceptions of social stimuli to decrease threat and encourage contact. Research may also use perceptions of threatening stimuli as a measurement throughout the therapy process as markers of progress.

Finally, further research should distinguish between the perceptual bias as a positive or negative facet. In anxiety, is bringing threatening stimuli closer actually advantageous? This depends on whether or not the individual is attending to the threat. The entire notion of anxiety is that the threat is not being acknowledged, and therefore bringing the threat close may be a means of the mind kicking in to make the physical body approach the threat, however it is still up to

one's conscious control as to whether they deal with the threat. According to the New Look approach, bringing stimuli closer make them easier to react to, but on the contrary this may cause greater anxiety when the stimulus is attended to but not dealt with (Bruner, 1992). Following this logic, the correlational results may indicate that high trait anxiety causes the perceptual bias, but it may also follow that the bias is what causes the anxiety. Further research should differentiate the two and the interaction between them.

These findings are not just relevant to the millions of people with social anxiety disorders. Findings are also relevant to people today because for the first time in history, American culture is at its prime individualist state. People are divided and competitive, and the presence of technology feeds this mental state and heightens isolative tendencies. In the past two decades, Americans have decreased their social networks by a third and the average number of confidents in now 0, instead of the 3 twenty years ago (Brashears, McPherson, & Smith-Lovin, 2006). In this type of society, the amount of people feeling social anxiety is rapidly increasing. Our ideas of community are deteriorating in the face of greed, independence, and opposition. This mentality innately causes stress and anxiety, and decreases face-to-face human interaction. Now especially, it is paramount that all of the mechanisms behind social anxiety are understood so that the best treatment can be developed and be administered.

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Appendix A: Survey

Part I.

1. How far away does the video camera feel?

1	2	3	4	5	6	7
Very Close						Very Far

2. This piece of paper is 11" long, almost a foot. Using that basis, how many feet away do you think the video camera is?

   _____ft

3. How large does the video camera seem?

1	2	3	4	5	6	7
Very Small						Very Large

4. Close your eyes, and take a moment to visualize your height. Now, looking at the board against the wall choose which line, labeled A through M, correctly represents your height.

   _____

Part II.

Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel **right now, at this moment**. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	Not at all	Somewhat	Moderately	Very much
I feel calm	1	2	3	4
I am tense	1	2	3	4
I feel upset	1	2	3	4
I am relaxed	1	2	3	4
I feel content	1	2	3	4
I am worried	1	2	3	4
I feel stressed	1	2	3	4

Part III.

Directions: For each question, please circle a number to indicate the degree to which you feel the statement is characteristic or true of you. The rating scale is as follows:

0	1	2	3	4
Not at all characteristic or true of me	Slightly characteristic or true of me	Moderately characteristic or true of me	Very characteristic or true of me	Extremely characteristic or true of me

I have difficulty making eye contact with others.	0	1	2	3	4
I find it difficult mixing comfortably with the people I work with.	0	1	2	3	4
I tense up if I meet an acquaintance on the street.	0	1	2	3	4
I feel tense if I am alone with just one person.	0	1	2	3	4
I have difficulty talking with other people.	0	1	2	3	4
I find it difficult to disagree with another's point of view.	0	1	2	3	4

Gender: M__ F__

Do you have normal vision?

If not, do you currently have corrected vision (wearing contacts or glasses)?