Friends Serve to Lighten Our Load: The Role of Social Resources in Visual Perception

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Abstract

Recent research suggests that slant perception is scaled by social costs and resources; those imagining negative social support give higher slant estimates than those imagining positive social support. However, there has been no systematic investigation on how individual differences might interact with both social support and varying social environments to produce changes in visual perception. Furthermore, given an embodied account of perception, it is unclear how social support might function to alter visual perception. First, the effect of social support on slant perception was replicated, with added measures to assess individual differences.

The current study found that both the costs and benefits of social support are amplified for those that rely more on their social network. Extroverts and securely attached individuals benefit more from positive support but exhibit a higher perceptual cost when imagining a betrayal. Next, two studies investigated whether supportive physical touch can serve as a signal regarding the availability of physiological resources. These studies found that supportive physical touch can raise blood glucose levels, but only for securely attached individuals; alternatively, for insecurely attached individuals, supportive physical touch resulted in a decline in blood glucose. In these studies, social support varies with attachment style to function as either a signal for additional physiological resources or as a physiological cost. The third experiment investigated whether the effects of social support on visual perception generalizes to all aspects of perception. In this study, social support was shown to only affect target distance estimates, which can be scaled with physiological resources, but does not affect block size nor reach ability estimates, which are scaled by morphology. Together, these study results suggest that social support alters visual perception by signaling the availability physiological resources. Finally, a large online study conducted a systematic investigation into the various aspects of social support that might uniquely predict slant estimates. The study had null results, which could be due to a lack of affordances or the lack of a social environment. Together, the above findings elucidate the complexities of the interactions between individual differences and social environments that produce changes in visual perception, and emphasize the pervasive nature of the social environment on even the most basic of cognitive processes, visual perception.

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1. Introduction

1.1 The Information for Visual Perception

Visual information consists of the angular distribution of reflected light at a point of observation. As individuals move in the environment, this angular distribution changes in a lawful way, called optic flow, which specifies the spatial layout of the environment from which the light was reflected (Gibson, 1979). A useful animation demonstrating this point can be viewed at http://www.faculty.virginia.edu/perlab/misc/bookanimations/. The visual system's use of this information is twofold; it informs the visual guidance of action and is the basis for explicit perceptual experience. There is evidence that the visual system acts directly on changes in visual angles to guide action (for a review, see Fajen, 2007, and van der Kamp, Oudejans, & Savelsbergh, 2003). However, our explicit perceptual experience cannot be comprised in these angular units. Instead, optic flow must be transformed into linear units appropriate for specifying size and extent. The geometrical manner by which optical information is transformed into apparent size and distance has been studied extensively (Proffitt & Caudek, 2013). How this information has been scaled has been studied less; however, existing accounts point to the body as providing the effective perceptual rulers (Proffitt, 2006; Proffitt & Linkenauger, 2013).

1.2 The Body as a Perceptual Ruler

A seminal example of how the body can serve as a perceptual ruler was provided by Sedgwick (1986), who demonstrated how the observer's eye-height can be used to calculate the heights of objects. When gazing straight ahead in the environment, the observer's line of sight corresponds to the horizon line; the height of any object where it intersects the horizon line is the same as the perceiver's eye-height. For example, suppose Bob's eye-height is 6 feet and he is looking at a pole that extends above the horizon line. The height from the bottom of the pole to the horizon line corresponds to Bob's eye-height, and so it is 6 feet. As illustrated in Figure 1.2.1, the total height of the pole can be calculated as the ratio A/B, where A is the height from the top of the pole to the horizon and B is the height from the bottom of the pole to the horizon. Thus, B always corresponds to the eye-height of the perceiver. Determining the height of the pole requires a simple calculation of the proportion from the top of the pole to the horizon (A) relative to the perceiver's eye height (B). For example, if 1/3 of the pole Bob is seeing extends above the horizon, the height ratio of A to B is 1:2. Since we know Bob's eye height is 6 feet, the height of the pole extending below the horizon is 6 feet, the height of the pole extending above the horizon must also be 3 feet, and thus, the height of the entire pole is 9 feet.

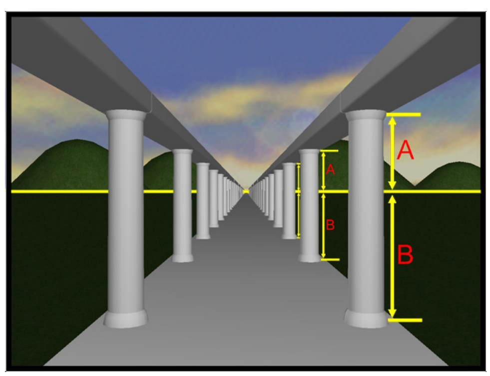


Figure 1.2.1. In the above figure, the yellow horizontal line represents the horizon. The height of the pole can be calculated as the ratio A/B. A is the height from the top of the pole to the horizon and B is the height from the bottom of the pole to the horizon, which corresponds to the perceiver's eye-height.

Now, suppose Suzy's eye-height is shorter than Bob's. Interestingly, from her viewpoint more of the pole will extend above the horizon (A) and the height from the bottom of the pole to the horizon (B) will appear smaller. Because her B is smaller than Bob's, her A/B ratio will be larger than his. Therefore, Suzy will perceive the pole as much bigger than does Bob because her ruler, her eye-height, is smaller (see Figure 1.2.2).

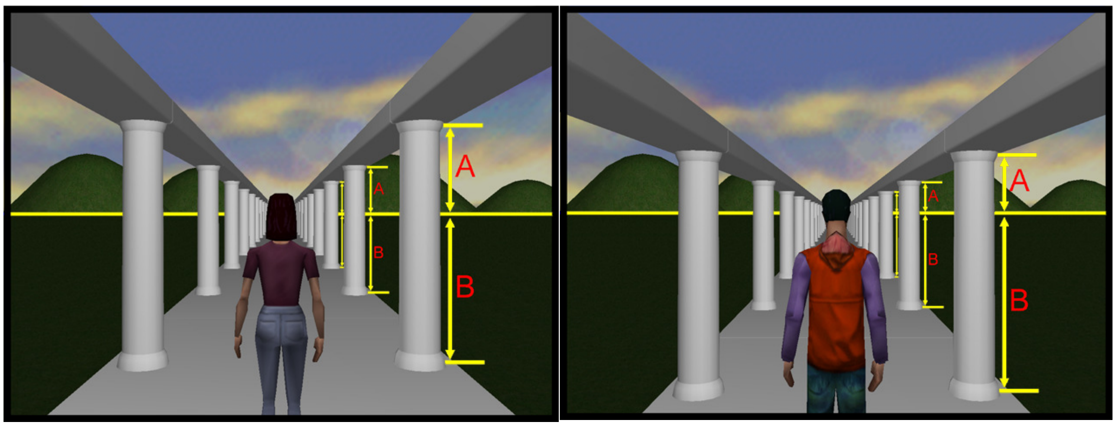


Figure 1.2.2. For both Bob (right) and Sue (left), the horizon corresponds to the perceiver's eye-height. Since Sue is shorter than Bob, the proportion of the pole extending above the horizon (A) is larger. Her perceptual ruler, her eye-height, is smaller and so she perceives the same pole to be bigger than Bob.

1.3 Perception as a Phenotypic Expression

Eye-height alone, however, has limited utility as a perceptual ruler (Proffitt, 2013; Wraga & Proffitt, 2000). For example, the utility of eye-height is limited to situations where both the observer and the target object are stationed at ground level and the ground plane is relatively flat. Moreover, eye-height is neither useful for scaling the size of a coffee cup on a table nor the distance to objects much beyond 20 meters. Eye-height is useful in certain situations, but in others different perceptual rules must be applied. These rulers derive from the body's phenotype; where a phenotype is comprised of the body's morphology, physiology, and behavioral repertoire (Proffitt & Linkenauger, 2013).The aspect of the phenotype that is selected to serve as the perceptual ruler depends on what is relevant for acting in the environment. If Sue is thirsty and needs a sip of water to drink, what becomes relevant is whether or not the bottled water in front of her is reachable. In this situation, her visual perception of the distance to the bottled water is best expressed in terms of her arm length. Once she establishes that the water is reachable, she needs to pick up the bottle. Now Sue's arm length is not particularly helpful. Instead, her hand size is the relevant aspect of her body for the task, and her visual perceptual system expresses the size of the bottle as a proportion of hand size. In both cases, the visual system scales the environment to the relevant aspect of the body needed for action. What follows is a brief review of the literature supporting the claim that visual perception varies with changes in the body's morphology, physiological resources, and behavior.

1.3.1 Morphology. Morphology consists of the body's semi-permanent form, composition, and size (Proffitt & Linkenauger, 2013). As previously discussed, the selected perceptual ruler depends on the aspect of the body relevant for acting; for example, when reaching for objects, arm length is the relevant structure of the body's morphology. In reaching, the action boundary is the point in space at which an object is just reachable and the space within the action boundary is defined as near space (Cutting & Vishton, 1995). Neural evidence demonstrates that the brain maps near space to include objects that are within arm's reach, and cognitive neuroscience provides compelling evidence for the psychological reality of the near space distinction as defined by the perceptual ruler, reach ability. Patients with left visual neglect will ignore the left half of the visual field and exhibit a rightward bias when asked to bisect a line. Patients with left visual neglect only in near space will not exhibit a bias for lines outside of their reachability. However, these patients will show a rightward bias to far lines if their arms' reach is extended with a stick (Cowey, Small, & Ellis 1994; Halligan & Marshal, 1991), and recent fMRI research with healthy participants also indicates that the extending arm's reach remaps near space (Gallivan, Cavina-Pretasi, & Culham, 2009). Additionally, single-cell recordings in monkeys have found that neurons responding to objects within near space are also sensitive to reachability. Iriki, Tanaka, and Iwamura (1996) extended monkeys' reach with a rake and found that the visual neurons coding near space adjusted and responded to objects within the reach of the rake. From the above studies, it is evident that the visual system is sensitive to the body's reachability ruler.

Like the neural maps of near space, visual perception to objects within near space are also sensitive to arm's length and reachability. It must be the case that if distance perceptions are scaled to arm length when reaching, then extending the reach of the arm via tool use gives the visual system longer ruler to scale the distance to the object. For example, suppose Sue's bottled water is 12 inches away. If her ruler is also 12 inches long, the bottle of water is one ruler length away. If Sue measures the distance with a ruler that is 24 inches long, the water is now .5 ruler lengths away. Similarly, extending the length of the arm with a tool should result in a compression of distance for the now reachable objects (see Figure 1.3.1 for an illustration of this principle).

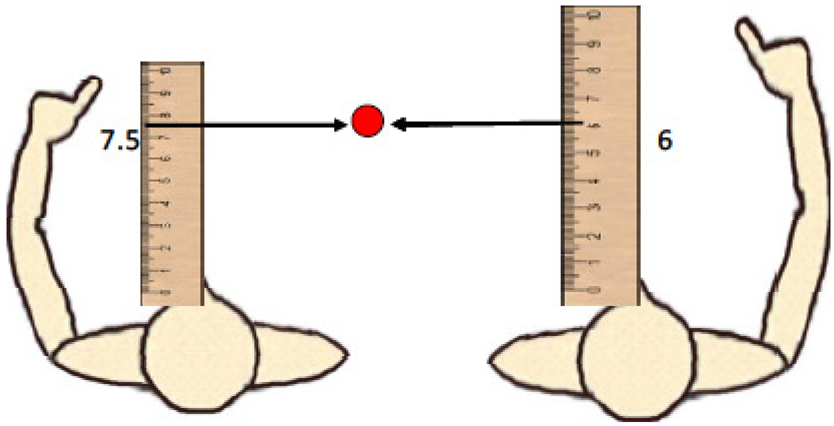


Figure 1.3.1. The red target dot is the same distance away for both participants. Since the participant on the left has a shorter arm than the participant on the right, their ruler is compressed and the dot is perceived to be farther away.

Indeed, research shows that when participants are allowed to reach with a tool, objects previously outside of arm's length but within the extended action boundary are perceived as closer than when reaching without the tool (Witt, Proffitt, & Epstein, 2005; Witt & Proffitt, 2008). This effect has been replicated with indirect measures of distance (Witt, 2011), and with remote tool use (Bloesch, Davoli, Roth, Brockmole & Abrams, 2012). These studies clearly demonstrate that our visual perceptions of distance to objects in near space are scaled to the length of our reachability ruler.

Other aspects of the body's morphology also affect visual perception. In addition to the previously discussed eye-height and reaching studies, research shows that hand size influences the estimations of indirect measures of the size of objects (Haggard & Jundi, 2009; Linkenauger, Mohler, & Proffitt, 2011; Linkenauger, Ramenzoni, & Proffitt, 2010; Linkenauger, Witt, & Proffitt, 2011), the ability to walk through a gap affects perceived sized of doorways (Stefanucci & Guess, 2009), the ability to jump across gaps alters the perceived size of the gap (Lessard, Linkenauger, & Proffitt, 2009), and altering the perceived body size in virtual reality changes the perceived size of the virtual reality world (van der Hoort, Guterstam, & Ehrsson, 2011). In a given situation, our visual perceptions are scaled to that aspect of the body that is relevant for acting in the environment.

1.3.2 Physiology. Imagine walking across a large, rolling field. In this environment, there are a number of candidates for scaling distance and slant perception. One could imagine the distance is represented in the number of steps required or even total travel time. Since all biological organisms must regulate their energy intake and consumption (Schrodinger, 1945), an especially useful perceptual ruler is the body's physiological costs associated with walking the extent. A review of the research indicates that for long distances and hill slants, visual perceptions are scaled to the amount of physiological energy required to traverse the extent relative to the amount of bioenergetic resources available (Proffitt, 2006; Proffitt & Linkenauger, 2013).

In general, the visual system overestimates the slants of hills (see Figure 1.3.2). Participants standing at the bottom of a 10 degree hill estimate the slant to be approximately 30 degrees (Proffitt, Bhalla, Gossweiler, & Midgett, 1995). Furthermore, participants who are not physically fit, are physically fatigued, elderly, or weighed down with a heavy backpack report the slant of a hill to be steeper than their counterparts (Bhalla & Proffitt, 1999).These results indicate that participants also report hills to appear steeper when their energy potential is decreased.

Figure 1.3.2. Participants estimating the slant of a hill. On the left: The participant is using a palm board to estimate an approximately 25 degree hill. Without looking at her hand, she adjusts the slant of the board to match the slant of the hill. On the right: The participant visually adjusts a disc so that the slope of the moveable piece matches the slope of the hill, which measures approximately 6 degrees.

Subsequent research suggests the perception of hill slant is directly linked to a physiological measure of energy, blood glucose. In one study, participants fasted prior to participation, and were assigned to either drink a sweetened or sugar-free drink. Following a depleting cognitive task, the participants who consumed the sugary drink reported the slant of a hill to be less steep than those who drank the sugar-free version (Schnall, Zadra, & Proffitt, 2010). In another study, participants gave slant estimates and then chose a drink to consume from a variety of beverages. The participants that gave steeper slant estimates were more likely to choose energy-replenishing drinks (Taylor-

Covill & Eves, 2014). This research demonstrates that our perceptions of slant depend, in part, on the available physiological energy to act in the environment.

There are similar findings in the literature for distance perception. Walking in the environment always produces a corresponding change in optic flow. When walking is accompanied with no optic flow, participants implicitly learn walking effort is required to remain stationary (Anstis, 1995). In virtual reality environments, experimenters can independently manipulate participants' walking speed and optic flow. In one such study, participants learned that more walking effort is needed by walking on a treadmill in a virtual environment with zero translational optic flow. Subsequently, these participants estimated distances in the environment to appear farther (Proffitt, Stefanucci, Banton, & Epstein, 2003). Additionally, distance perception has also been directly linked to blood glucose. Cole and Balcetis (2013) had participants fast and then consume either a sweetened or sugar-free drink. Participants who drank the sugared drink reported distances to appear closer than those who drank the sugar-free version.

Research in individual differences in physical fitness provides the strongest evidence for the claim that distance perception is scaled to physiological energy. In one study, participants' maximal aerobic capacity (VO2) max at blood lactate threshold, the gold-standard measure of physical fitness, predicted distance perception (Zadra, Schnall, Weltman, & Proffitt, in press). Individuals higher in fitness perceived distances to be closer compared to individuals lower in physical fitness. Collectively, this body of work suggests that the visual perceptual system is sensitive to the physiological energy required to act in the environment. When the amount of available energy is low, the perceptual ruler is smaller, and so hills appear steeper and distances appear farther.

1.3.3 Behavior. Finally, an organism's behavioral repertoire also functions to influence visual perceptions, which is especially salient in goal-directed behavior. Goals influence what actions people intend to perform, and the selected action in turn determines what aspect of the body is relevant for use as a perceptual ruler. As discussed previously, when reaching for an object, arm length is relevant; when ducking under a branch, head height is relevant. Moreover, research demonstrates that the notion of relevance includes the intention to act. Objects within the reach of a tool do not appear closer if the participant is holding the tool, but does not intend to reach with it (Witt et al., 2005). Following an optic flow manipulation where participants have implicitly learned that it takes more energy to walk, distances do not appear closer if the participants intend to throw a beanbag to a target, rather than walk the distance (Witt, Proffitt, & Epstein, 2004). An individual's goals influence intended actions, which in turn determine what aspect of the phenotype is relevant for scaling visual perception.

In goal-directed behavior, performance predicts perception of target size. Softball players with a better batting average perceived a softball to appear larger (Witt & Proffitt, 2005), golfers who were better putters reported that the target hole appeared bigger (Witt, Linkenauger, Bakdash, & Proffitt, 2008), participants with better performance in throwing darts perceived the target to be larger (Canal-Bruland & van der Kamp, 2009; Canal-Bruland, Pijpers & Oudejans, 2010; Wesp, Cichello, Gracia & Davis, 2004), and field goal kickers with better performance perceived the distance between the goal posts to be larger (Witt & Dorsch, 2009). Here, the notion is that the relevant perceptual ruler is the variability distribution of performance for target-directed actions. When putting performance is good, the distribution of putts around the target hole is smaller, and so the target appears larger, and vice versa (see Figure 1.3.3). For target-directed behaviors, the relevant perceptual ruler is the variability in performance around the target.

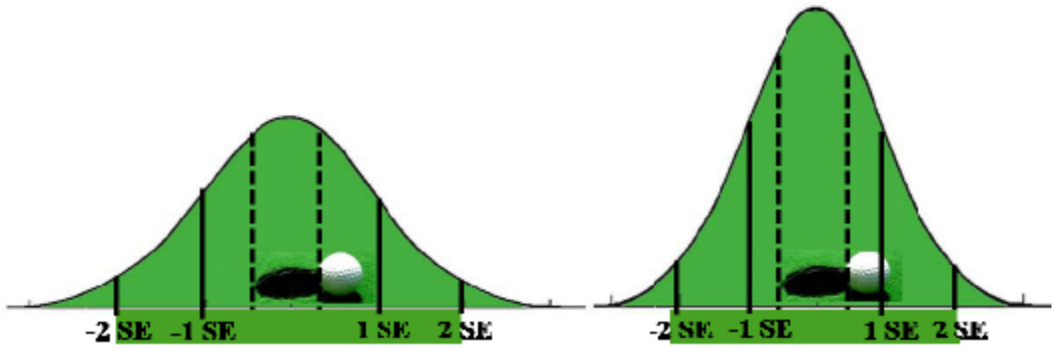


Figure 1.3.3. Each curve represents the variability of putting performance, which is the ruler by which the hole size can be scaled. On the left: For a putter with worse performance, the variability around the hole is larger, and so the hole is perceived to smaller. On the right: For a putter with better performance, the variability around the hole is smaller, and so the hole is perceived to be larger.

1.4 Social Resources and Visual Perception

Humans are social animals that function as part of complex social environment. Our relationships with others offer valuable social resources. Like physical resources, social resources have also been shown to alter visual perception. Schnall and colleagues (Schnall, Harber, Stefanucci, & Proffitt, 2008) recruited participants either walking alone or walking with a friend and obtained visual estimates of slant. Participants walking with a friend estimated the hill to be less steep. Moreover, there was a significant positive relationship between visual slant estimates and the length of the friends' relationship; the longer the friendship the less steep the perceptual estimates (Schnall et al., 2008).

Participants who imagined a supportive friend also gave lower slant estimates (Schnall et al., 2008). This effect was replicated with another study where participants who browsed the Facebook profile of a supportive friend also gave lower slant estimates (Faulkner & Clore, 2012). Finally, in another study, researchers induced a sense of felt understanding or misunderstanding between participants. Those who felt understood by their fellow participants gave lower slant estimates (Oishi, Schiller, & Gross, 2013). The presence of or imagining a supportive other are indications of social resources, and our visual perceptions are influenced by these social resources.

Alternatively, social environments do not always indicate more available social resources. The presence of others may also signal a potential cost to the perceiver. Indeed, individuals perceive aggressive male students to be standing closer than non-aggressive male students (Cole, Balcetis, & Dunning, 2013), and threatening out-group members are perceived to be closer than non-threatening out group members (Xiao & van Bavel, 2012). Interestingly, recent work in visual perception suggests that highlighting the potential costs of cooperating on a task will negate the benefits of working together (Meagher & Marsh, 2014). In a series of studies, participants expected to carry a heavy box a distance of 10 meters, and were assigned to either carry the box jointly with a confederate or alone. When the researchers made the difficulty of coordinating the task salient, participants in the joint-carrying condition estimated the distance to be farther (Meagher & Marsh, 2014). The nature of the social environment varies, and our perceptual system is sensitive to the fact that social networks can function both as an added benefit or an added cost.

1.5 Baselines in Social Resources

In order to evaluate and budget for the potential resource costs and benefits of an action, it is necessary to first determine a baseline, or the amount of resources the body will seek to maintain. Like a household budget, there is typically some desired positive value of savings around which income and expenditures are balanced. Rather than spending all of your income, some amount of monetary resources is protected. When the amount of savings dips below the baseline, resources are conserved by cutting unnecessary expenditures until the savings are restored. Alternatively, when the savings value is higher than the baseline, expenditures might increase.

There is evidence that the concept of a baseline is paramount to evaluating social resources. In the social support literature, not receiving social support is most detrimental when support was expected, and receiving unexpected social support is more beneficial than receiving expected social support (Bergeman et al., 2010). That is, the costs and benefits of social support are evaluated relative to baseline expectations. What remains, then, is to define and determine the components that set the expected social baseline with which we evaluate our social resources.

Social Baseline Theory (SBT), addresses this issue (Beckes & Coan, 2011; Beckes & Coan, 2012; Coan, Brown, & Beckes, 2014). For much of psychology, the unit of analysis is focused solely on the individual; the assumption being that the presence of social support adds resources to an otherwise self-sufficient individual. SBT asserts that the individual's default state is to assume social support. In other words, an individual's social baseline, by which an environment is determined to be costly or beneficial, includes the individual and part of their social network (Beckes & Coan, 2011). As social animals, people assume the presence of social support, which decreases the cost of acting by load sharing (Coan et al., 2014). A person's social baseline assumes the presence of social support, and thus, to study an individual in isolation is to study someone whose resources are taxed. However, just as variability exists in physiology across individuals, there exist differences in the social baselines of individuals. While almost all people function embedded in a social network, individuals will differ in the amount and quality of anticipated social resources. This dissertation will investigate, in part, the individual differences that interact with social resources to produce variation in how social resources affect visual perceptions.

1.6 Individual Differences in Social Resources

SBT proposes that the individual's baseline resources are composed of both their own resources and those in their social network. I propose that social baselines vary across individuals and are determined, in part, by our early life experiences. In biology, studies in life history theory show that, across a wide range of organisms, nutritional deficits early in life are followed by an initial compensation that results in costly deficits later in life (Metcalfe & Monoghan, 2001).Variability in early life changes the organism's baseline to be lower such that, over time, they will show nutritional and growth deficits.

Similarly, in attachment style theory, variability in early life experiences in caregiver relationships will affect an individual's relationship styles well into adulthood (Bowlby, 1969). Children whose caregivers were attentive and responsive to their needs will develop a secure attachment style; they are comfortable and confident in their current relationships. On the other hand, if a child's primary caregiver responded inconsistently, the child will often develop an insecure or anxious attachment style. Insecurely attached individuals are concerned about the reliability and dependability of their current relationships (Ainsworth, Blehar, Waters, & Wall, 1978; Bartholomew & Horowitz, 1991). Similar to findings in biology, variability in early life relationships will negatively affect an individual's relationships over their lifetime.

Indeed, insecurely attached participants rate supportive acts as less supportive than securely attached individuals (Collins & Feeney, 2004) and report more anxiety preceding a social stress test (Ditzen et al., 2008). This research suggests that anxiously attached individuals benefit less from social support than do securely attached individuals. In regards to visual perception, since anxiously attached individuals will not benefit as much from the social support manipulation as securely attached individuals, and so I hypothesize that anxiously attached individuals in social contexts should report higher slant estimates than securely attached individuals.

Furthermore, extraversion refers to a stable personality trait characterized by a motivation to seek social contact (Matthews & Gilliland, 1999). Introverts, individuals low in extroversion, report smaller social support networks (Stokes, 1985; Cohen, Doyle, Skoner, Rabine & Gwaltney, 1997; Swickert, Rosentreter, Hittner & Mushrush, 2002), less interaction with their support networks, are less likely to seek out their social network (Amirkhan, Risinger & Swickert, 1995; Halamandaris & Power 1995), and report lower perceived social support (Swickert, Hittner & Foster, 2010). Because extroverts tend to rely more on their social network than introverts, extroverts should be more sensitive to changes in the social environment. As such, I predict that extroverts will report lower slant estimates than introverts when receiving social support, but will perceive hill slants to be steeper than introverts in the face of a social betrayal.

1.7 Mechanisms for How Social Resources Alter Perception

The second aim of this dissertation is to investigate the mechanism by which social resources alter visual perception. Given that our visual perception is scaled to the body's phenotype (Proffitt & Linkenauger, 2013), there are two possible mechanisms by which the social environment can influence visual perception, which are not mutually exclusive. First, social resources could be interchangeable with physiological resources. That is, social resources function by lowering the physiological cost of acting because they signal, literally, additional available physiological resources. Second, social resources could alter our beliefs about our behavioral potential by increasing a general sense of our ability to act. If this is the case, social resources should expand the perceived ability to act across a variety of tasks. Each possibility is discussed in turn, below.

1.7.1 Social Resources Are Analogous to Physiological Resources. One of the body's main sources of physiological energy is sugar, stored as glycogen in the liver and muscles and as glucose in the bloodstream (Benton, Parker & Donohoe, 1996). Lower blood sugar indicates that there is less bodily energy available and signals a higher cost to acting in the environment. Indeed, slant perception varies with changes in blood glucose; participants with lower blood glucose levels, brought about by a depleting cognitive task, perceived hills to be steeper than those who were given caloric supplementation prior to the depleting task (Schnall et al., 2010). Importantly, blood glucose is also the primary source of energy available to the brain, which, in turn, uses roughly 20% of the available glucose in the blood stream (Galliot & Baumeister, 2007). As a result, ten to fifteen minutes of performing a challenging cognitive activity will result in measurable drops in blood glucose levels (Galliot & Baumeister, 2007). In other words, demanding cognitive activity can lower the body's blood glucose supply and raise the physiological cost of acting in the environment. In fact, recent studies suggest that individuals that have engaged in a demanding cognitive activity, which presumably raises the physiological cost of acting in the environment by increasing the demand on blood glucose, perceive distances to be farther than those that do not engage in difficult cognitive tasks (Zadra, 2013).

In human physiology, the body works to conserve resources by maintaining a homeostatic baseline. For instance, when blood glucose levels decline or rise, the body releases glycogen or insulin, respectively, to maintain a certain baseline (Benton et al., 1996), which ensures that a relatively constant amount of blood glucose is available to body. In an economy of action account (Proffitt, 2006), visual perception works to inform the perceiver of the cost of an action by scaling the environment to the available physiological resources. This serves to help the body budget future resources by discouraging costly bioenergetic actions.

When acting in the environment, the net cost of an action is equal to the bioenergetic cost of the action with respect to available bioenergetic resources. The net cost of the action can be reduced by either decreasing the energy needed to perform the action itself or by increasing the available physiological resources. One possible mechanism for how social resources affect perception is that social resources function to signal the availability of additional physiological resources. In the presence of the social support, the pool of available resources increases because it is now comprised of the perceiver's and the supportive other's physiological resources. When budgeting for future actions, social support also lowers the net cost of acting in the environment by signaling more available physiological resources. When recovering from energy expenditure, social support increases the pool of *potential* physiological resources, which affords the body the ability to expend more resources to restore to baseline. Furthermore, the extent to which social support signals additional resources reflects the extent to which an individual relies on a social network for support. As such, the restorative effects of social support should vary with individual differences.

1.7.2 Social Resources Alter Beliefs about Behavioral Potential. An alternative explanation for the effect of social support on visual perception is that social support generally alters our beliefs about our ability to act in the environment. With respect to the body's phenotype, this suggests that social support affects perception by changing beliefs about behavioral potential. This explanation is akin to a recently published study on putting and visual perception. In this study, participants were lead to believe that the putter used in the study belonged to a famous golfer. As a result of this belief, participants became better putters and perceived the golf hole to be bigger (Lee, Linkenauger, Bakdash, Joy-Gaba, & Proffitt, 2011). Presumably, using a pro golfer's putter altered participant' beliefs about their putting abilities, a phenomena known as positive contagion, resulting in corresponding changes in visual perception. Social support could function similarly, where recalling a supportive social network changes a general belief that the world is easier to navigate, thereby altering visual perception.

1.8 Summary

Visual information must be converted from angular units to linear units, which necessitates a ruler to scale the units. Previous research suggests our visual perceptions are scaled to both our phenotype, consisting of our body's morphology, physiology, and behavior, and our social resources. Specifically, increasing the physiological cost of acting makes hills appear steeper and targets appear farther; on the other hand, imagining supportive others makes hills appear less steep. Previous research suggests that the benefits of social support vary with how connected the individual is with their social network, which motivates a systematic study of the individual differences that interact with social resources to alter visual perception, and what exactly constitutes a social resource. Furthermore, if perception is scaled to our phenotype, as the research suggests, it is unclear how or where social resources fit into our phenotype to scale perception. Two alternatives are: social resources signal available physiological resources and social resources change beliefs about our behavioral potential. In sum, the aim of this dissertation is to investigate individual differences in how social resources affect perception, address possible mechanisms for how social resources might function with respect to visual perception, and determine what aspects of the social environment constitute a social resource.

2. Study 1: Individual Differences and Social Support

Study Overview

In general, individuals that interact with or imagine supportive others perceive hills to be less steep (Schnall et al., 2008; Faulkner & Clore, 2012). However, the social support literature suggests that the effectiveness of social support varies with individual differences. Therefore, the goal of Study 1 was to establish whether individual differences also interact with social support to predict differences in visual perception. Specifically, the proposed study investigated how attachment style and extraversion, measured via self-report questionnaires, are related to social support and visual perception. It was hypothesized that individuals that are higher in extraversion and have a secure attachment style should see the hill has less steep than introverts or those with an anxious attachment style when imagining supportive others, but more steep when imagining a person that has betrayed them.

Method

Participants

One-hundred nine students from the University of Virginia community (73 women) aged 17-27 (M = 18.92, SD = 1.43) participated for either course credit or $5.00. Participants were required to have normal or corrected-to-normal vision and normal walking mobility. Fourteen participants were excluded due to an error in the recorded imagery file and three participants were excluded for correctly guessing the hypothesis, for a final sample size of 93 (62 women).

Stimulus

Participants gave slant estimates of a grassy, 26 degree hill on the grounds at the University of Virginia. Participants stood on nearly flat ground at the bottom of the hill and faced the hill, which extends over 13 meters before leveling off to a road at the top of the hill (see Figure 2.1, below).

Figure 2.1. The hill used in Experiment 1.

Materials

Imagery task. The imagery task consisted of a set of instructions directing participants to visually image and think about another person. The task consisted of listening to a recorded audio file played on an Apple iPad, over Sony headphones. The speaker was a male graduate clinical psychology student, who read directly from a written script, see Appendix A.

Backpack. Participants wore a backpack that held free weights, equaling approximately 20% of the participants' self-reported body weight. For this experiment, the backpack was used to increase the energetic cost of acting in the environment, thereby increasing the relevance of resource manipulation.

Visual Disc. The visual disc consisted of a blue disc with a moveable piece of green poster board and a protractor attached on the back side of the disc, shown below in Figure 2.2. Participants adjust the dark green piece to match the slant of the hill.

Palm Board. The palm board is constructed by affixing a flat board atop a digital protractor, which is mounted to a camera tripod with a level, see Figure 2.2 below. The height of the board is adjusted to hip level, and participants place their palms flat on the board to adjust the slant of the board to match the slant of the hill.

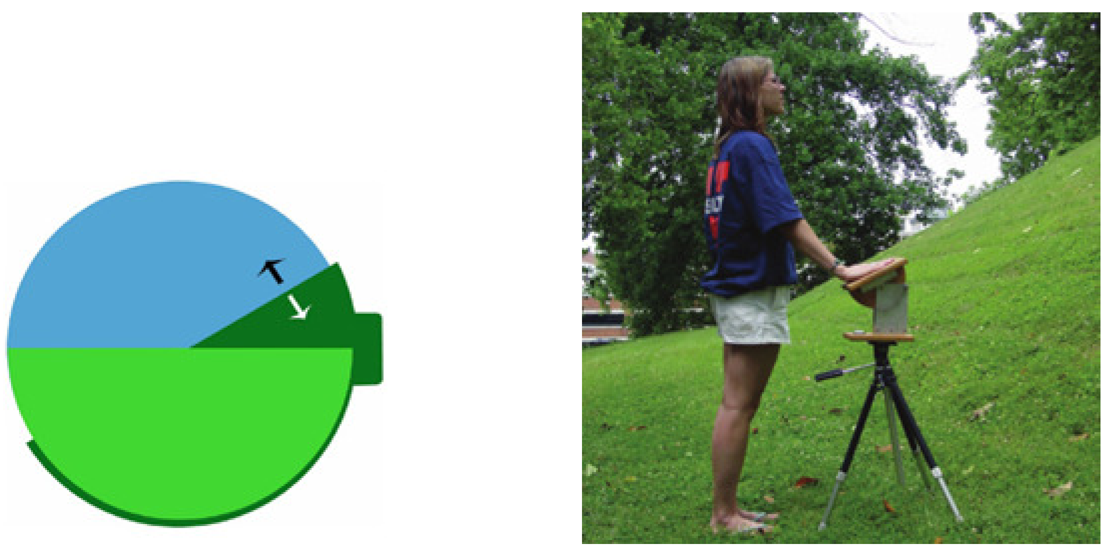


Figure 2.2. On the left, the visual disc. On the right, the haptic board.

Individual Differences Questionnaires. Participants answered a 60-item Extraversion scale (Goldberg et al., 2006; see http://ipip.ori.org/), which consists of items adapted from the Neuroticism-Extraversion-Openness Inventory (Costa & McCrae, 1992). In the questionnaire, participants rated their agreement with a series of statements, such as “I prefer spending time with my friends” on a 1 to 5 scale, where 1 indicates Strongly Agree and 5 indicates Strongly Disagree. The answers are divided and averaged into scores for six different constructs of extraversions: friendliness ($\alpha = .87$), gregariousness ($\alpha = .79$), assertiveness ($\alpha = .84$), activity level ($\alpha = .71$), excitement-seeking ($\alpha = .78$), and cheerfulness ($\alpha = .81$). Participants also answered the Experiences in Close Relationships Revised (ECR-R), a 36-item measure that yields a score on attachment anxiety and avoidance (Fraley, Waller, & Brennan, 2000). In the ECR-R Participants rate their agreement with items such as “It’s not difficult for me to get close to my partner.” on a 1 to 7 scale, where 1 indicates strongly disagree and 7 indicates strongly agree. Finally, participants answered a questionnaire assessing demographics, mood, and a manipulation check (see Appendices B-D for full copies of the questionnaires).

Procedure

Participants met the researcher at the top of the hill, and, after consenting to the study, they climbed down to the base of the hill. The researchers explained that the participants would do a few different tasks: complete a visualization task, give estimates, and answer questionnaires. There were three between-subjects conditions in the study, which were counterbalanced across participants: positive, neutral, and negative. In the positive condition, participants imagined a close, supportive friend; in the negative condition they imagined someone who used to be a friend but had betrayed or let them down somehow; and finally, in the neutral condition participants were imagined someone that they were familiar with but did not know well, such as a store clerk (see Appendix A).

For the imagery task, participants were led to sit on a blanket on the grass shaded by a tree approximately eight meters from the base of the hill. They were told that all instructions for the visualization task were recorded in the audio file. The participants donned the headphones, and, the researchers adjusted the sound volume if needed, and then walked back to the base of the hill while participants sat quietly and completed the imagery task as instructed.

Next, participants were led to stand to the left of the palm board, facing the base of the hill. They donned the weighted backpack, gave three estimates of the slant of the hill in counterbalanced order. For the visual task, participants were instructed to look straight ahead at the hill for the entirety of the task. They adjusted the slant of the green moveable piece of the visual disc to match the apparent slope of the hill. For the verbal task, participants just answered the following, “How steep is this hill, in degrees, if zero were perfectly flat and 90 was a vertical wall?” For the haptic task, they were explicitly instructed to look straight ahead and not to glance down at their hand. The participants put their right hand on top of the palm board, and were told to adjust it backwards so that the slope of their hand on the board matched the slant of the hill.

Following the slant estimates, participants answered, in the following order, the Extraversion, Experiences in Close Relationships – Revised, and Social Support Manipulation and Demographic Questionnaire. They were probed for the study purpose, debriefed, and thanked for their participation.

Results and Discussion

The manipulation check indicated that those in the Positive condition imagined significantly more pleasant images ($M_{Positive} = 4.31$, $SD_{Positive} = .85$), followed by the Neutral condition ($M_{Neutral} = 3.48$, $SD_{Neutral} = .72$), then the Negative condition ($M_{Negative} = 2.06$, $SD_{Negative} = 1.05$, $F(2,89) = 50.62$, $p < .0005$, see Figure 2.3). There was no effect of mood or attachment style on any of the slant estimates, and there were no significant effects of condition on the haptic or verbal measures.

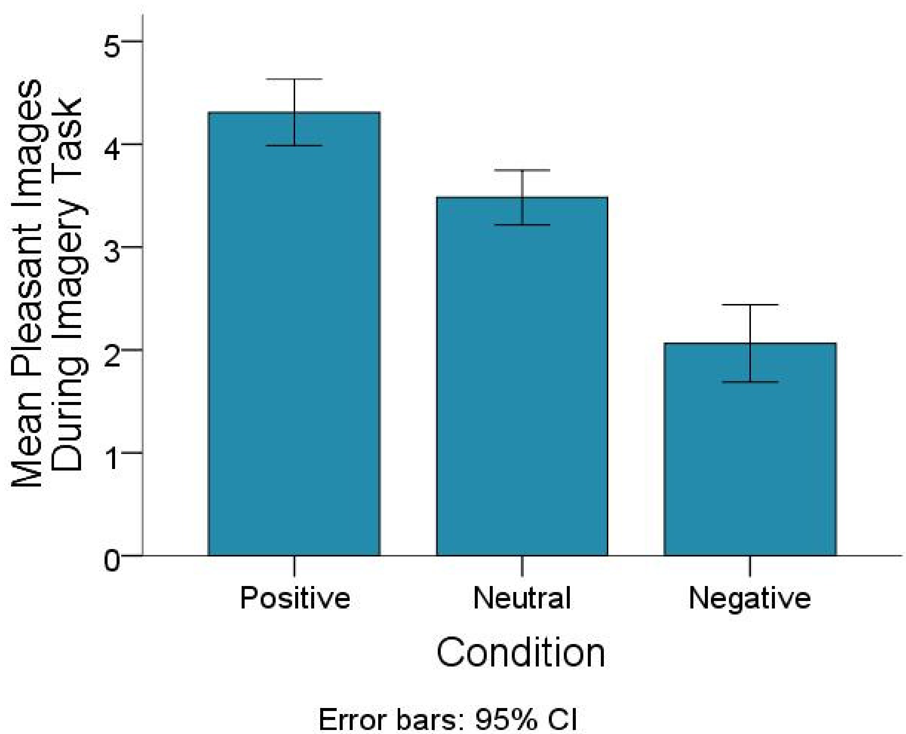


Figure 2.3. Manipulation check for Experiment 1.

A multiple regression was used to predict visual slant estimates. The model consisted of condition (Positive, Neutral, Negative) and gender as factors, friendliness as a covariate, and the two-way interactions between condition and gender, and condition and friendliness. For the visual slant estimates there was a significant main effect of condition ($F(2,83) = 3.48$, $p = .035$. $\eta_p^2 = .08$); those in the Positive condition ($M_{Positive} = 51.06$, $SE_{Positive} = 2.09$) gave lower visual slant estimates than those in the Negative condition ($M_{Negative} = 53.78$, $SE_{Negative} = 2.02$,), see Figure 2.4 below.

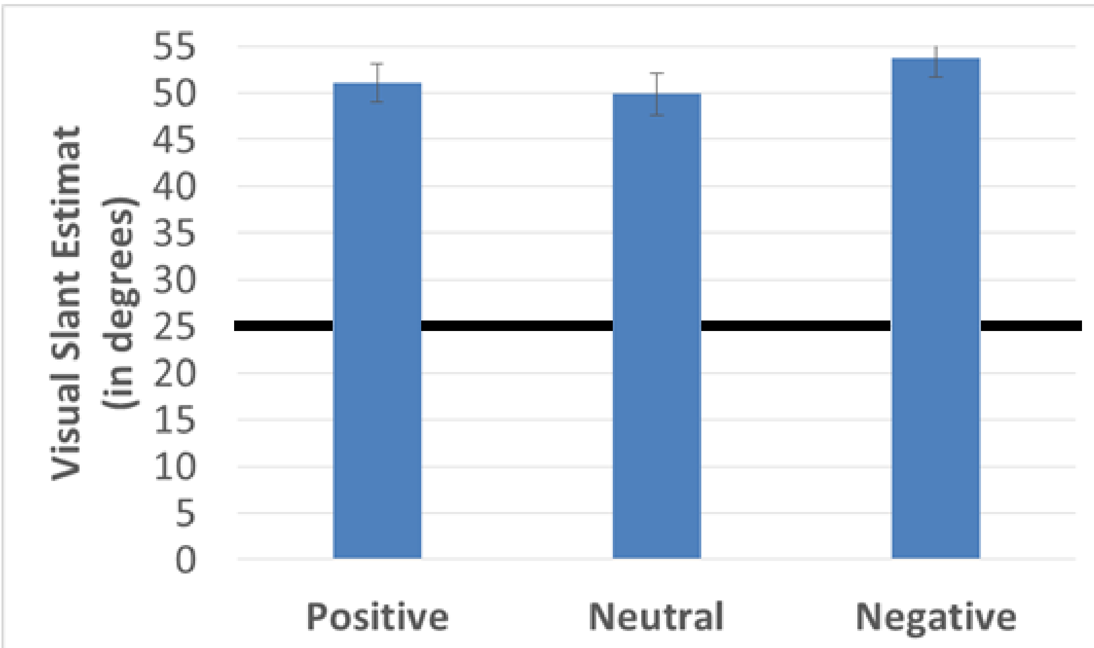


Figure 2.4. The main effect of condition; those in the Positive condition estimated the slant to be lower than those in the Negative condition. The black line corresponds to the actual slant of the hill, 26 degrees. Error bars +/- SE.

There was also a significant gender by condition interaction on visual slant estimates $F(2,83) = 4.49$, $p = .014$. $\eta_p^2 = .10$). Women in the Positive condition gave lower slant estimates than women in the Negative and Neutral conditions. However, men gave lower estimates in the Neutral condition, and had no difference between their estimates in the Positive and Negative conditions, see Figure 2.5 below.

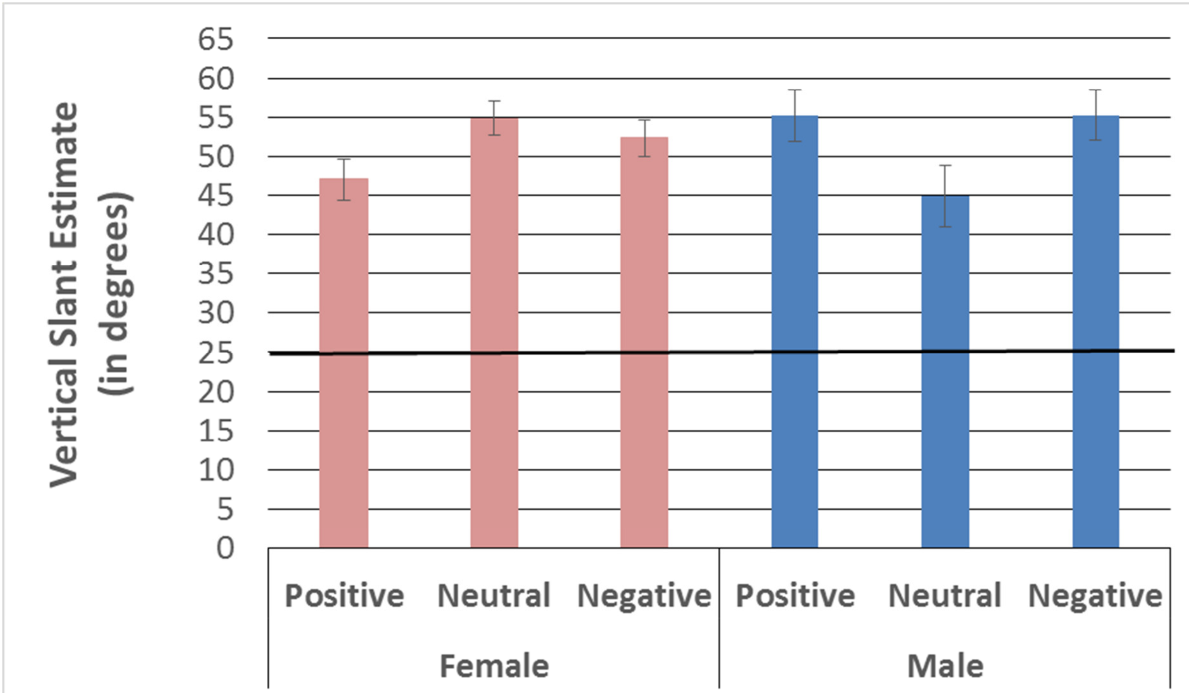


Figure 2.5. The condition by gender interaction; women in the positive condition gave the lowest slant estimates, but men in the neutral condition gave the lowest slant estimates. The black line corresponds to the actual slant of the hill, 26 degrees. Error bars +/- SE.

Finally and most importantly, there was a significant friendliness by condition interaction on visual slant estimates (F(2,83) = 4.04, p = .021, $\eta_p^2 = 0.09$. In the Positive condition, those high on friendliness gave shallower slant estimates, but in the Negative condition those high on Friendliness gave steeper slant estimates (see Figure 2.6). There were no significant main effects of gender and friendliness (both F's <.380, both p's > .539).

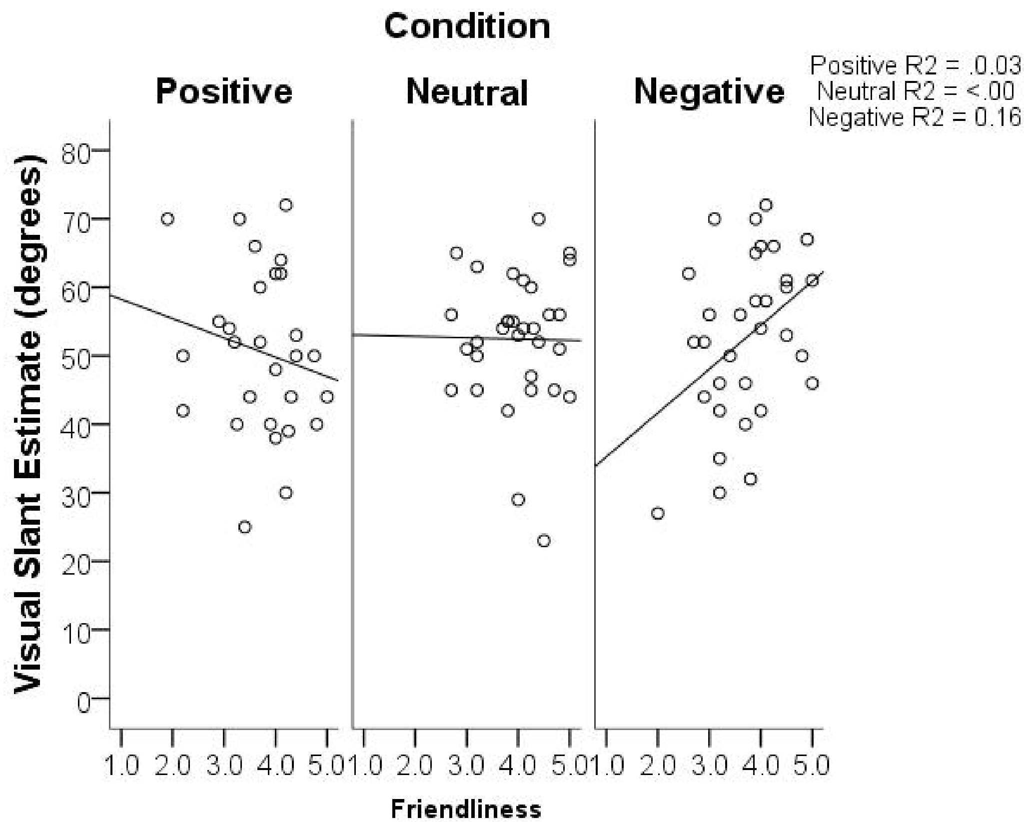


Figure 2.6. In Experiment 1, the predicted Friendliness by Condition interaction. In Friendliness, higher numbers indicate higher Friendliness score.

These results replicated previous research that suggests that social support alters slant estimates; on average, those that imagined a supportive other gave lower slant estimates than those that imagined someone who had betrayed them. The results also confirm the hypothesis that individual differences interact with social resources to predict changes in visual perception. First, men and women responded differently to the social support manipulation. Women in the Positive condition gave lower slant estimates than those in the Negative and Neutral condition, whereas men in the neutral condition gave the lowest slant estimates. This interaction was unexpected, but does support the notion that social resources interact with individual differences. Secondly, across individuals, there is variability in their preference for social engagements. In this study, those high in friendliness, a measure of extroversion, benefitted the most from social support; when imagining supportive others, the more extroverted the individual, the lower the slant of the hill appeared. This suggests that perceptual changes in response to social support are not ubiquitous. It depends, in part, on the individual's socialization preferences.

Moreover, social environments are not uniformly supportive. In general, the results show that those imagining someone who has betrayed them estimate the hill to be steeper than those imagining supportive others, and this effect also interacts with individual differences. Those low in friendliness, or more introverted individuals, were less affected by the negative support manipulation. That is, in the Negative support condition individuals low in friendliness reported the hill to be less steep than those that were high in friendliness. These results highlight the potential cost to those that are highly dependent on their social network. While introverts may miss out on the benefits of social support, they are protected in negative social environments. On the other hand, extroverts visualizing a person that has betrayed them perceived hills to be steeper than introverts. In negative social environments, extroverts incur a higher cost than introverts, and literally see the world as more challenging.

3. Study Set 2: Social Resources Signal Additional Physiological Resources

Overview of Studies

Currently, researchers have suggested that, analogous to physiological resources, social resources affect visual perception. However, there is little to no discussion regarding a mechanism for how social resources might work to alter perception. I propose that social resources function by signaling the availability of physiological resources. Experiments 2a and 2b provide evidence that the provision of a social resource, holding hands, works to restore or prevent depletion in one of the body's main sources of energy, blood glucose.

3.1 Experiment 2a: Social Resources and Blood Glucose

Study Overview

One of the ways the body ensures a relatively constant supply of energy is by conserving baseline blood glucose levels, either by releasing insulin when blood sugar levels are elevated or releasing stored glucose to raise depleted energy levels (Benton et al., 1996). In the current study, participants first performed hard cognitive tasks in order to deplete their blood glucose levels. If social resources signal additional physiological resources at the body's disposal, then the presence of social resources should signal the body to release blood sugar back into the bloodstream. Furthermore, previous research indicates that the benefits of social support vary with individual differences in attachment style and extroversion. Extroverted individuals and those that are securely attached benefit more from social support (Swickert et al., 2010; Collins & Feeney, 2004). Thus, it is hypothesized that, following a cognitive depletion task, individuals' blood sugar levels will restore when provided with social support, but only for extroverted and securely attached individuals.

Method

Participants

The study consisted of 56 females from the University of Virginia (M = 18.35 years, SD = 0.60, age range: 18-20 years). Participants were recruited in pairs through the University of Virginia's Participant Pool system. Prior to the study, participants were instructed to bring a friend to also participate in the study, informed of the required finger pricks, and asked to refrain from eating or drinking anything but water for three hours before the study began. One participant was excluded from participating due to a failure to adhere to the fasting guidelines, six participants were excluded for dieting, and two were excluded due to failure to obtain an accurate glucose reading, resulting in a final N of 47. All participants gave informed consent, and they were either given course credit or compensated $15 for participation in the study.

Materials

Blood glucose meter. Blood glucose levels were measured by analyzing a drop of blood from a finger prick with a Hemocue 201 Glucose tester.

Stroop Task. The researchers used Microsoft Powerpoint to deliver the Stroop task (MacLeod, 1991). The Stroop task consisted of six pages of word lists of colors, and all words were written in a different color font than the color it stated. For example, one word in the list might consist of the word green written in red font, or the word black written in blue font. The participants were instructed to ignore the meaning of the word and to instead state aloud the font color of each word, and to "go through the list as fast as possible but without making any mistakes.” An error consisted of any instance in which the participant stated or began to state the word as opposed to the ink color. During the Stroop task, the researchers recorded the number of errors and timed how long it took the participant to complete the entire task.

Brown-Peterson Task. The Brown-Peterson Task (Brown, 1958, Peterson & Peterson, 1959) was delivered with Microsoft Powerpoint. The task requires holding a three letter string, or trigram, in working memory while simultaneously performing a serial subtraction task. Researchers read the trigram aloud to the participant, who immediately repeated the trigram out loud, and then began the serial subtraction task. For this portion, the participants were given a random number in the hundreds, and instructed to count backwards by three’s until the program asked them to stop and recall the trigram. The length of the serial subtraction task, and therefore the amount of time the participant held the trigram in working memory, varied between three to 18 seconds with each trial. The participants completed 30 trials, and researchers recorded the total number of trigrams remembered correctly during the task. A trigram was counted correct if participants recited all three letters in the correct order.

Questionnaires Researchers used the program MediaLab to give a series of questionnaires at the end of the study, which included items to measure personality traits, attachment style, and the relationship quality with the friend (see Appendix E for a complete list and copies of all questionnaires administered).

Procedure

Two female researchers ran the friend pairs in the study simultaneously. Upon their arrival, the researchers immediately separated both participants and seated them at desktop computers in two adjacent rooms. After obtaining informed consent, the researchers inventoried all food and drink consumed by the participant in the past 12 hours to ensure compliance with the fasting rule. If participants did not follow the fasting request, they were excluded from participating in the rest of the study. Otherwise, the researchers performed the first of three finger pricks in order to assess baseline blood glucose levels.

Following the baseline blood glucose test, the participants performed two cognitively fatiguing tasks, the Stroop Task and a Brown-Peterson task. Participants first engaged in the Stroop task, which took, on average, 4 minutes and 31 seconds. Afterwards, participants performed the Brown-Peterson task. Both participants completed the same variations of the Stroop and Brown-Peterson task, and the participants did not receive any feedback regarding their performance on the tasks until after the debriefing. After finishing both cognitive tasks, the participants gave another finger prick to assess blood glucose levels following cognitive fatigue.

Next, the participants were randomly assigned to one of three social support conditions. The experiment was double-blind in that neither the researchers nor the participants knew the assigned condition until the handholding session began. During the Friend condition, participants were brought into the same room, seated back-to-back, and instructed to hold hands without speaking or otherwise interacting with each other for 10 minutes. For the Stranger condition, two additional female research assistants, whom the participants had not previously met, sat back-to-back with the participants and quietly held their hands for 10 minutes. In the final condition, the Alone condition, the participants were instructed to sit quietly by themselves for 10 minutes, and to take care not to fall asleep or use their cell phones. For the Alone and Stranger condition, the participants remained seated in their separate rooms, and did not interact with their fellow participant. Following this period of holding or not holding hands, participants gave a final blood glucose measure.

Lastly, the participants completed a battery of questionnaires (see Table 3.1.1 for a complete list). Importantly, before starting the questionnaires, the researchers gave each participant a dish of 50 skittles. The participants were told that the skittles were "for being in the study". The researchers left the room while the participants completed the questionnaires. When the participants were finished, the researchers probed for suspicions about the purpose of the study, debriefed and thanked the participants, and counted the remaining skittles to determine the number eaten.

Table 3.1.1

A complete list of questionnaires administered in Experiment 2a

60-item Extraversion Scale
Experiences in Close Relationships-Revised
Inclusions of Others in Self
Relationship Status Items
The Four Love Aspect Measure-Revised (The FLAMe-R)
The Perceived Relationship Quality Component
The Positive and Negative Affect Scale – Now and General
The Behavioral Inhibition/Behavioral Activation Scale
Trait and State Anxiety Inventory
Fatigue Severity Scale
Multi-Fatigue Inventory
Multidimensional Perceived Stress Scale
Penn State Worry Questionnaire
Big Five Inventory
Relationship Scales Questionnaire

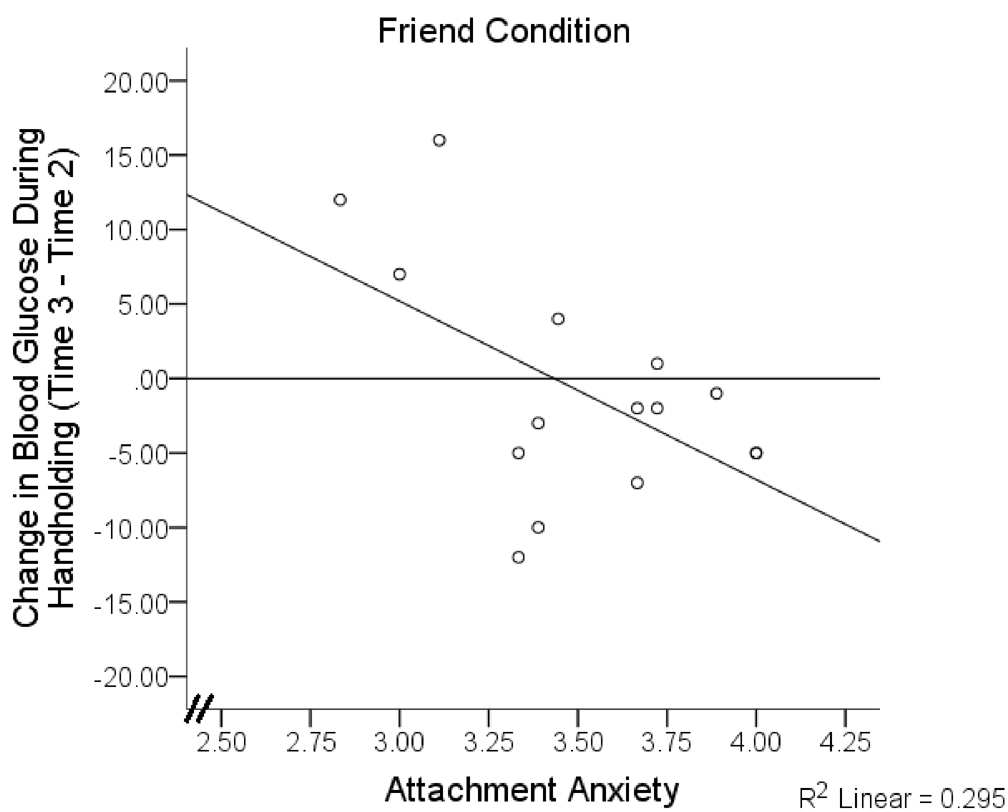
Results and Discussion

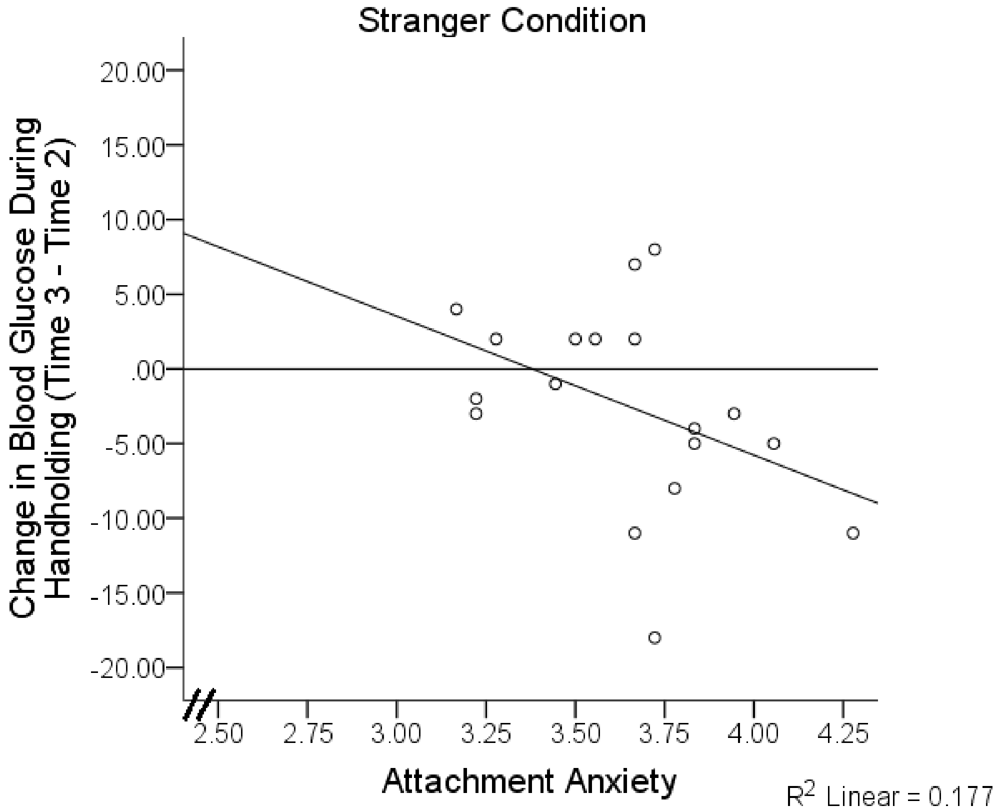
Descriptive statistics show that, across all conditions, participants' scores on attachment anxiety were near the mid-point overall (M = 3.60, SD = .03, on a scale from 1 to 7, with 7 being anxiously attached), participants consumed on average 34 skittles (M= 33.79, SD = 15.42), and participants' last oral intake of food was, on average, 7.4 hours prior to participating in the study (M = 7.42, SD = 3.88).

To test the depletion and restoration effects, the glucose levels were converted into change scores. A hand-holding blood glucose change score was calculated by subtracting the post-cognitive task glucose scores from the post-handholding glucose scores, and a cognitive depletion glucose change score was calculated by subtracting the glucose scores at baseline from the post-cognitive task glucose scores. A positive change score indicates blood glucose increased during the time period, whereas a negative change score indicates that blood glucose decreased.

There was no overall depletion effect during the cognitive depletion tasks. On average, participants glucose scores following the cognitive tasks increased slightly (M = 1.25, SD = 15.55), a one-sample t-test indicates that this change was not significantly different from 0 ($t(47) = 0.56$, $p = .580$).

To test the effect of handholding, a one-way ANCOVA was performed including hand-holding blood glucose change (Time 3 - Time 2) as the dependent variable, support condition as a fixed factor with last oral intake, attachment anxiety, and avoidance scores as covariates. As predicted, there was a two-way interaction with condition and attachment style such that handholding interacted with individuals' attachment style in the Stranger and Friend conditions, whereas in the Alone condition, there was no relationship between attachment style and the blood glucose restoration, $F(2, 35) = 5.35$, $p = .009$, $\eta_p^2 = .23$, see Figure 3.1.1. Somewhat surprisingly, for insecurely attached individuals in hand holding conditions, supportive physical touch resulted in a further decline in blood glucose, whereas blood glucose increased for securely attached individuals, see Figures 3.1.1 and Figure 3.1.2, below.




Stranger Condition
Change in Blood Glucose During Handholding (Time 3 - Time 2)
20.00
15.00
10.00
5.00
.00
-5.00
-10.00
-15.00
-20.00
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
Attachment Anxiety
R2 Linear = 0.177

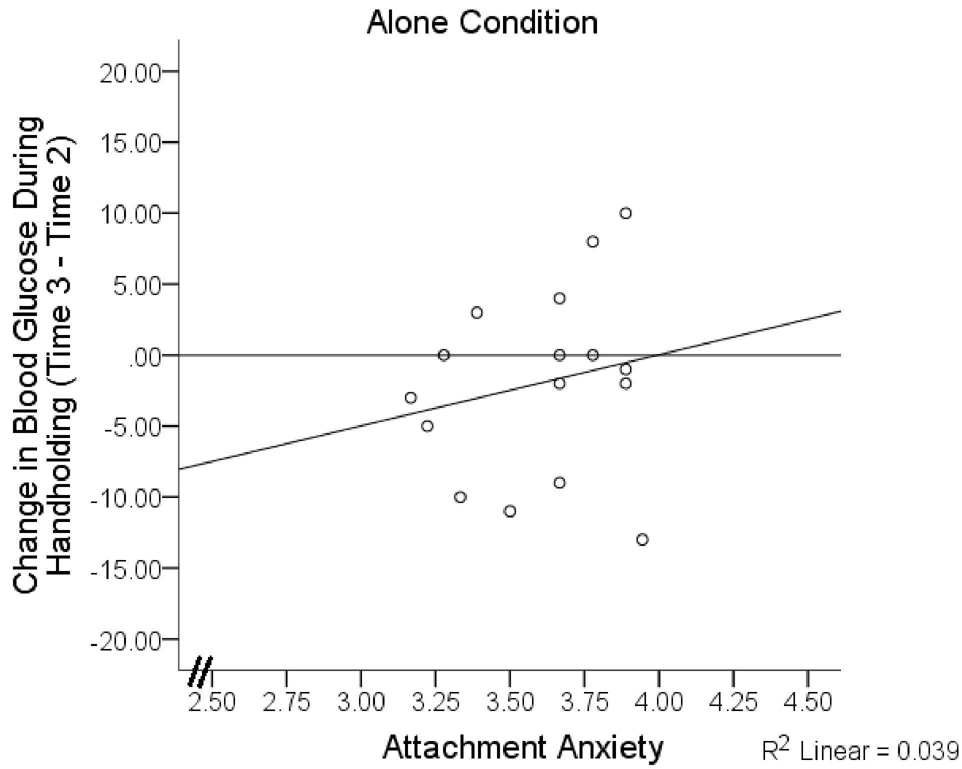


Figure 3.1.1. The relationship between attachment anxiety and changes in blood glucose during handholding, shown by condition. For attachment orientation, lower scores indicate attachment security and higher scores indicate attachment anxiety. For both the Friend and Stranger Condition (top two graphs), the more anxiously attached the participant, the more their blood glucose levels dropped during handholding.

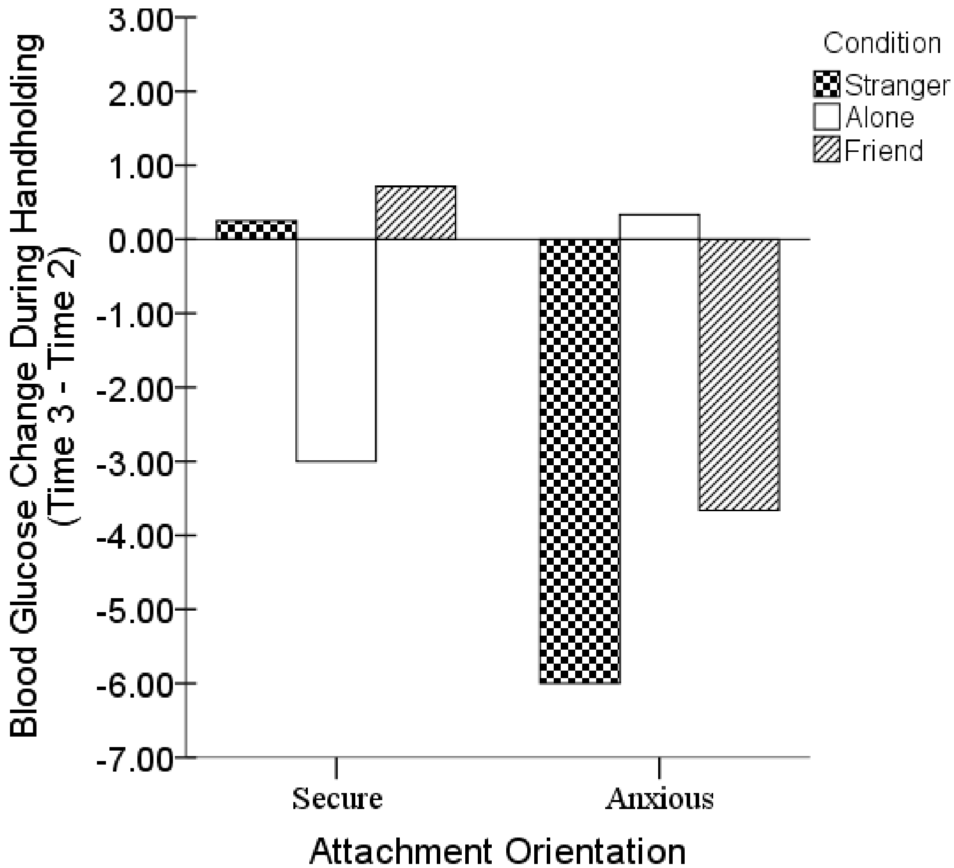


Figure 3.1.2. A descriptive graph depicting the interaction between attachment orientation and handholding, and the effects on the change in blood glucose. To create the attachment groups, researchers conducted a tertiary split on the data. The lowest third of the scores comprise the Securely Attached group and the highest third of the scores comprise the Insecurely Attached group. The graph shows that blood glucose levels remain stable for the securely attached participants in the both handholding conditions, but glucose levels drop during handholding if participants are anxiously attached.

Next, controlling for all of the two-way interactions with condition, last oral intake, attachment anxiety, and attachment avoidance, there was a significant main effect of hand-holding condition on blood glucose change, $F(2, 35) = 6.4$, $p = .004$, $\eta_p^2 = .27$. The estimated means for each hand holding condition indicated that blood glucose dropped more in the Friend condition (M = -4.20, SE = 1.99), than in the Alone condition (M = -1.9, SE = 1.51) and the Stranger condition (M = -1.65, SE = 1.59). Note that this is in the opposite direction than predicted; this finding is due to the decline in blood glucose for insecurely attached individuals during hand holding. Thus, the high scores in attachment anxiety drove the estimated means for blood glucose in the friend and stranger condition down. In other words, because of the main effect and interaction with attachment anxiety, the adjusted marginal means for the main effect of condition are estimated at a higher attachment anxiety score. Additionally, this main effect is qualified by the fact that the unadjusted means trend in the predicted direction ($M_{Friend} = -0.92$, $M_{Alone} = -1.94$, $M_{Stranger} = -2.44$). Simply put, the main effect of condition must be interpreted in light of the interaction between condition and attachment style.

Additionally, there was a significant condition by last oral intake interaction, $F(2,38) = 3.49$, $p = .041$, $\eta_p^2 = .155$, and the main effect of last oral intake was not statistically significant ($p = .150$), suggesting that the amount of time since participants last ate explains a significant amount of variation in glucose change scores. Unexpectedly, there was no effect of another measure of secure attachment, attachment avoidance, on changes in blood glucose, $F(2, 35) = 1.11$, $p = .341$.

Finally, to verify that candy consumption was related to the participants' physiological resources, a simple regression was performed with the number of skittles eaten as the dependent measure, and both the glucose depletion change score and restoration change scores as predictors. Surprisingly, as seen in Figure 3.1.3 , the glucose depletion change score significantly predicted skittle consumption, $b = -.42$, $p = .005$, but the glucose restoration change score did not, $b = .39$, $p = .22$, which could indicate a feedforward budgeting strategy. Individuals that were physiologically depleted during the cognitively fatiguing tasks later consumed more available resources. Notably, assigned handholding condition, attachment anxiety, and attachment avoidance did not significantly predict skittle consumption in any exploratory analyses.

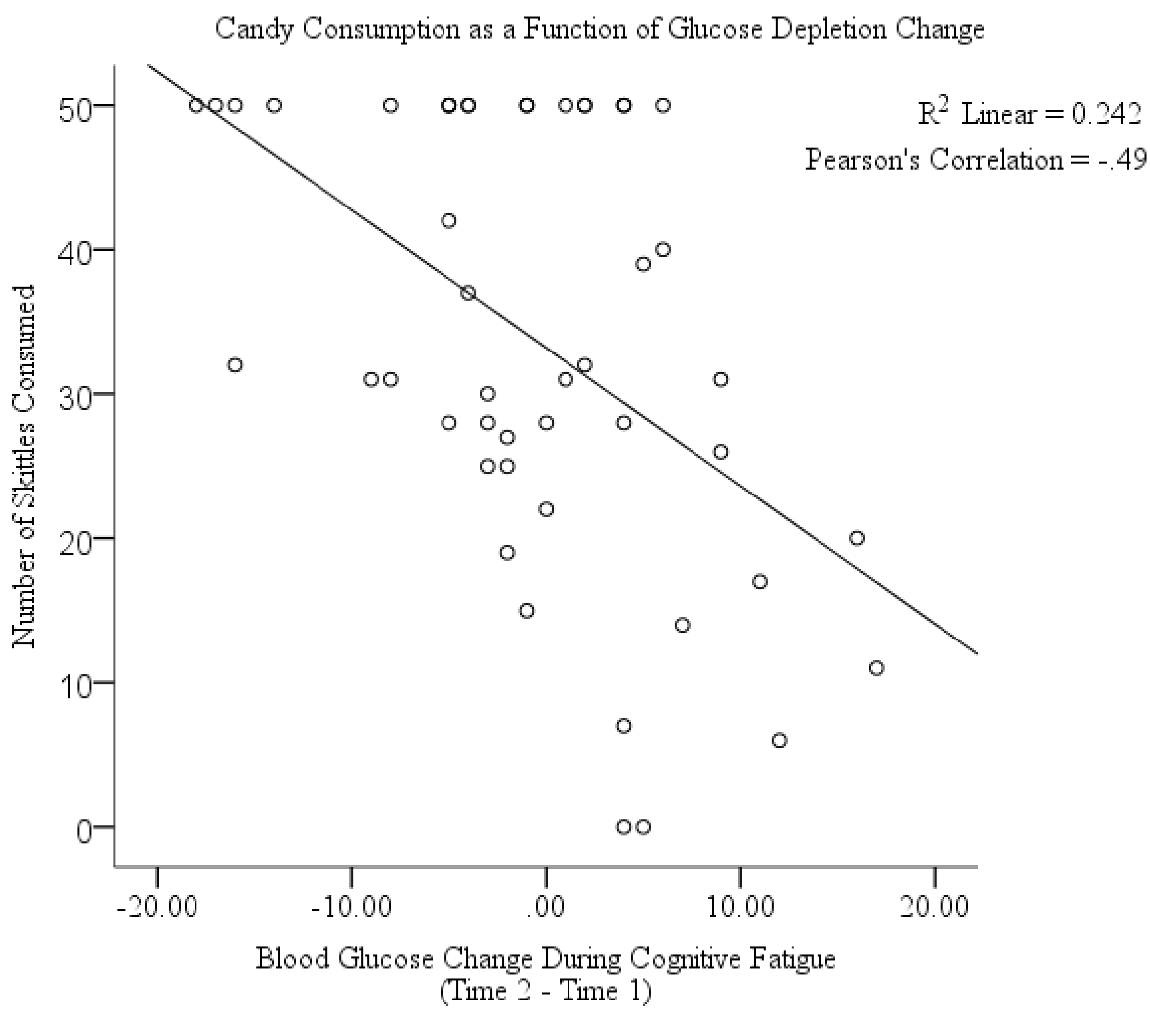


Figure 3.1.3. The relationship between the amount of physiological depletion during cognitive fatigue, measured by changes in blood glucose levels, and the amount of candy eaten following the hand holding manipulation.

In sum, social support serves as a signal regarding physiological resources, but the value of the signal depends on attachment style. Hand holding resulted in a net increase in glucose levels, but only for a few securely attached individuals. These results suggest that, for securely attached individuals, the presence of supportive physical touch may signal to the body that future physiological resources are available. Conversely, hand holding was, in fact, detrimental to the glucose levels of insecurely attached individuals. To insecurely attached individuals, social support can be an added cost.

There are several possible physiological explanations that would account for the changes in blood glucose due to an interaction between social support and attachment style. As discussed previously, the body acts in a feed forward mechanism in anticipation of fluctuations around baseline glucose levels (Benton et al., 1996). For a few securely attached individuals, hand holding could signal available physiological resources, resulting in a blood glucose increase. There are two possible scenarios that could produce this result: social support either slowed blood glucose metabolism or there was a release of glucose from the liver. For insecurely attached individuals, hand holding resulted in a decline in blood glucose. Again, in this case, social support either increased blood glucose metabolism or more blood glucose was transported out of the blood stream and stored in the liver and muscles.

Ultimately, these results first call to attention the role of individual differences in the effects of social support; individual variability in attachment style interacted with the effect of social support on blood glucose. The study also suggests that social support does directly affect the body's regulation of physiological resources, which in turn offers a possible mechanism for how social support affects visual perception. Previous research demonstrates that visual perception can be scaled to physiological resources (Proffitt, 2006; Proffitt & Linkenauger, 2013), and the current results suggest that social resources serve as a signal regarding the availability of physiological resources. It is possible that social support interacts with individual differences to change the pool of available physiological resources, thereby altering visual perception.

3.2 Experiment 2b: Replication of Social Resources and Blood Glucose

Study Overview

In Experiment 2a, there were two significant issues hindering interpretation of the results: the cognitive depletion measure did not significantly lower blood glucose and avoidant attachment did not predict changes in blood glucose. Replicating this study will confirm that social resources function to restore physiological depletion.

Method

Participants

Eighty-three participants completed Experiment 2b, age range 18-24 (mean = 19.53, SD = 1.36). Three participants were excluded for guessing the hypothesis of the study, for a final sample size of 80. All participants gave informed consent, and they were either given course credit or compensated $15 for participation in the study.

Materials and Procedure

Experiment 2b was a direct replication of Experiment 2a, with minor changes in condition assignment, the order in which questionnaires were answered, and the amount of skittles given to the participants. First, all participants answered a shortened version of the ECR as part of a pre-test for the department's participant pool. In order to ensure a roughly equal distribution of attachments styles across conditions, the researchers then used the derived pre-test attachment anxiety scores to pseudo-randomly assign participants to conditions. Second, all participants that initially signed up for the study answered a set of pre-screening questionnaires assessing individual differences, including extraversion and attachment style, before arriving to participate in the study. All other questionnaires were administered following the third blood glucose test (see Table 3.2.1 for a complete list of pre- and post-manipulation questionnaires, and Appendix E for complete copies of all questionnaires). All other participants answered both sets of questionnaires following the manipulation. All questionnaires were randomly presented with the exception that the Positive and Negative Affect Scale – Now always immediately followed the third blood prick. Additionally, due to ceiling effects in the number of skittles eaten in Experiment 2a, the number of skittles given to participants was increased to 100. Otherwise, all aspects of Experiment 2a were directly replicated.

Table 3.2.1

Questionnaires administered before (left) and after (right) the experimental manipulation in Experiment 2b.

Pre-Questionnaires	**Post-Questionnaires**
Positive and Negative Affect Scale - General	Positive and Negative Affect Scale - Now
Behavioral Inhibition/Behavioral Activation	Relationship Scales Questionnaire
Experiences in Close Relationships - Revised	The Four Love Aspect Measure -Revised
60-item Extraversion	State Anxiety Inventory
Trait Anxiety Inventory	The Inclusion of Self in Other
Fatigue Severity Scale	Relationship Status Items
Multi-Fatigue Inventory	
Multidimensional Perceived Stress Scale	
Big Five Inventory	
Penn State Worry Questionnaire	

Results and Discussion

First, three participants were excluded from any blood glucose analysis due to an mechanical error when testing blood glucose levels, and 16 participants were excluded from individual differences analyses due to the participants' failure to provide the code linking individual difference questionnaires to glucose data. A depletion change score was computed by subtracting the baseline blood glucose level from the post-cognitive depletion level, and a one-sample t-test revealed no significant drop in blood glucose following the cognitive depletion tasks, $M_{change} = -0.74$, SD = 8.75, $t(1, 76) = -0.55$, $p = .581$.

To test the effect of social support on blood glucose levels, a Type 1 sum of squares repeated measures ANCOVA was conducted with the three glucose measures (baseline, post-cognitive depletion, and post-hand holding) as the within subjects factor, hand holding condition (Alone, Stranger, and Friend) as a between-subjects factor, and attachment avoidance (M = 3.70, SD = 0.59) as a covariate. The number of skittles eaten (M = 21.45 , SD = 19.06) was included as a behavioral measure of depletion, and finally, to control for extraneous factors affecting blood glucose regulation, the model also included hours since last oral intake of food (M = 7.95, SD = 4.66) as covariates.

There was a glucose by condition interaction, $F(4, 106) = 2.77$, $p = .031$, $\eta^2_p = .09$ (observed power 74%), such that, following handholding, those in the Friend condition showed an overall increase in blood glucose, while those in the Stranger and Alone condition did not, see Figure 3.2.1 below. Furthermore, there was a significant glucose by condition by attachment avoidance interaction ($F(4, 106) = 2.89$, $p = .026$, $\eta^2_p = .10$ (observed power 76%). In order to analyze the three-way interaction, an overall glucose change score was computed by subtracting the baseline blood glucose levels from the post handholding glucose levels, which was then analyzed with a univariate ANCOVA consisting of the same factors and covariates listed above (skittles eaten, last oral intake, condition, and attachment avoidance). Participants in the Friend condition had an overall increase in blood glucose levels, but only if they had a secure attachment style, F (2, 54) = 3.72, $p = .031$, $\eta^2_p = .12$ (observed power 66%), whereas insecurely attached individuals in the Friend hand holding condition had a decline in blood glucose, see Figure 3.2.2, below.

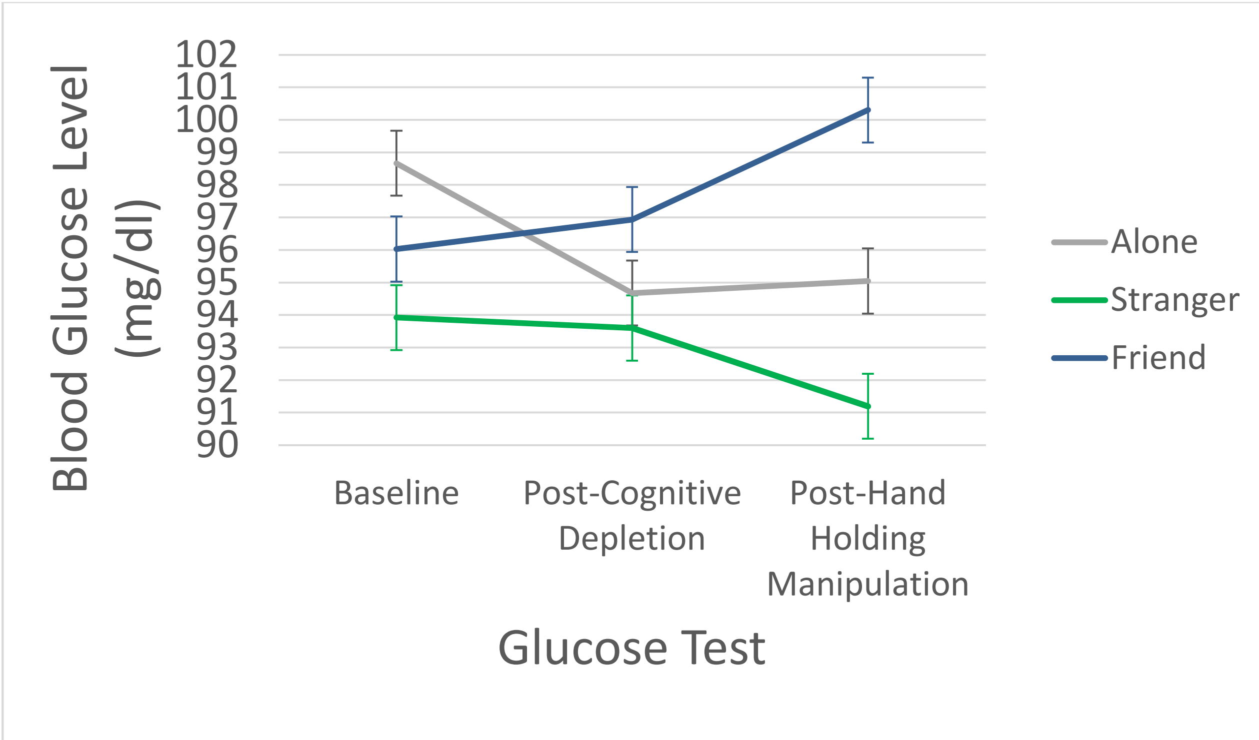


Figure 3.2.1. The glucose by condition interaction. During handholding, those in the Friend condition had an overall increase in blood glucose levels, compared to the Stranger and Friend condition.

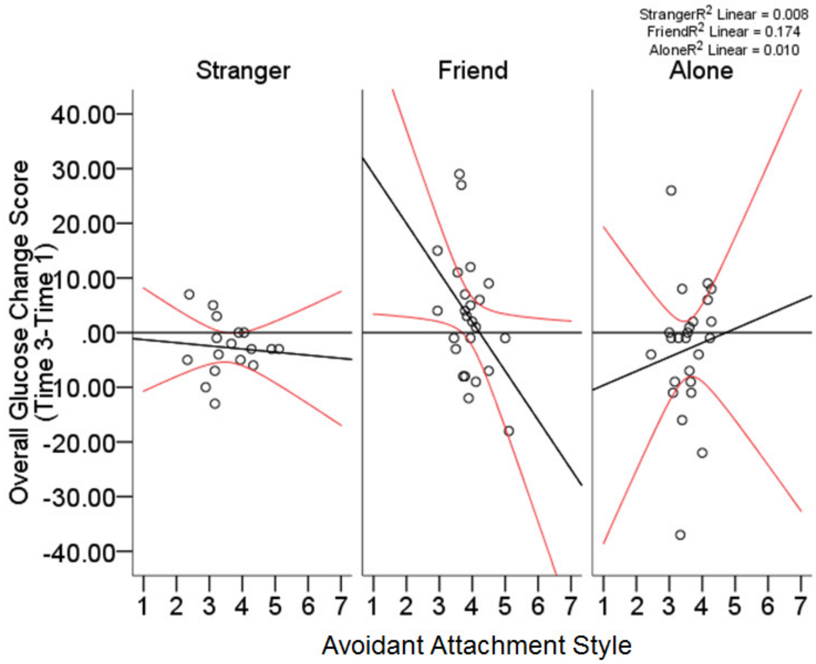


Figure 3.2.2. The interaction between condition and attachment style on overall change in blood glucose levels, where a score of 0 (horizontal black line) indicates no change, a positive score indicates that blood levels increased following hand holding and a negative score indicates blood levels decreased during this time. Higher avoidant attachment scores indicate lower levels of attachment security. The red lines represent 95% confidence intervals around the line of best fit. Hand holding for individuals with a secure attachment style resulted in an increase in blood glucose levels, but for insecurely attached individuals hand holding resulted in a decrease in blood glucose.

There was no glucose by skittles interaction (F (1, 54) = 0.07, p = 0.798), nor was there was there a glucose by last oral intake interaction (F (1, 54) = 0.02, p = .897). Also, there were no effects of mood, attachment anxiety (for main and interaction effects of attachment anxiety, all F's < .07, all p's > .891), or any other measured individual differences on blood glucose levels.

The goal of the current study was to replicate Experiment 2a's finding that provisions of social support are analogous to physiological resources such that holding hands interacts with attachment style to alter blood glucose levels. The replication was largely driven by two issues in interpreting the first study: the cognitive depletion task did not significantly deplete participants' blood glucose, and the interactions between social support and attachment style was only present for attachment anxiety, and not attachment avoidance.

First, the current study also failed to deplete blood glucose with a cognitive depletion task (Galliot & Baumeister, 2007). While unpublished studies in the lab have reliably demonstrated the depleting effect of cognitively fatiguing tasks on blood glucose, the failure to replicate this effect has been reported elsewhere in the literature (Xu et al., 2014). It is unclear why both Experiments 2a and 2b have also failed to replicate, but it is worth noting that, on average, participants fasted for 7.95 hours (SD = 4.66). It is possible that the body's regulation of a baseline blood glucose level prevented a further decline. Regardless, it is inappropriate to describe the findings as a restoration of blood glucose levels, since there was no actual decline to be restored. Still, the blood glucose for participants in the Friend condition did result in a net increase from the baseline glucose levels, despite having fasted prior to the study. The increase in blood glucose could either be achieved by releasing stored glycogen into the bloodstream or by dampening a physiological response that would remove blood glucose out of the bloodstream. Interestingly, supportive physical touch also served as a physiological cost to insecurely attached individuals. Again, this could be due to either engaging metabolically costly processes, such as those associated with stress, or by a physiological mechanism that pulled glucose out of the bloodstream and stored it in the liver and muscles.

Second, there was a significant interaction between social support and individual differences in attachment avoidance. While there was not a significant interaction between social support and attachment anxiety, the two subscales are two distinct constructs within attachment security (Fraley et al., 1999; Wei, Russell, Mallinckrodt, & Vogel, 2007). Indeed, in the current sample, there was not a significant correlation between attachment anxiety and avoidance scores ($r = -.06$, $p = .602$). Additionally, the attachment anxiety scores had a smaller range and standard deviation (range = 1.94, SD = 0.38) compared to attachment avoidance (range = 2.81, SD = 0.59), which suggests the lack of an interaction between social support and attachment anxiety could be due to the restricted range of scores. Finally, a recent published study (Ein-dor et al., in press) also found a positive association between attachment anxiety and baseline blood glucose levels, rendering it unlikely that the current results are an anomalous finding.

These results confirm that social support interacts with individual differences in attachment style to alter blood glucose levels. When given supportive physical touch, blood glucose levels for securely attached individuals will increase, whereas the blood glucose of individuals that generally fear intimacy and prefer to be self-reliant (Wei et al., 2007) will decrease with hand holding. This study highlights the importance of understanding individual differences in how participants relate to their social environments, as the physiological benefits of social support hinge on this relationship.

Even an overtly supportive action such as hand holding can result in a net benefit or cost, depending on individual differences. Finally, since social support can serve as a signal regarding the availability of (or lack thereof) additional physiological resources, it is possibly that social support alters visual perception via signaling information regarding physiological resources, thereby lowering the physiological cost of acting in the environment.

4. Experiment 3: Social Resources and Multiple Measures of Visual Perception

Study Overview

Experiments 2a and 2b suggest that social support alters visual perception by signaling additional physiological resources. An alternative explanation for the effect of social support on visual perception is that social support generally alters our estimated ability to act in the environment. With respect to the body's phenotype, this suggests that social support affects perception by changing beliefs regarding our behavioral potential.

To test whether social support generally expands behavioral potential or serves as a constituent of physiological resources, Experiment 2c will test the effect of social support on distance estimations, perceived reachability, and perceived object size. If social resources generally expand the perceived ability to act, variations in social resources should lead to changes in multiple modalities of visual perception, including perceived reachability and perceived object size. Since I expect social resources act to restore physiological depletion (Experiments 2a and 2b), this suggests that the mechanism for altering perception may be specific to lowering the physiological cost to acting. If this is true, then social resources should only alter visual perception in cases where perception is known to be scaled to physiological resources, such as distance perception, and should not affect all modalities of visual perception. It is hypothesized that the effects of social support are specific to instances where perception changes with physiological resources (distance perception), and will not generalize across perceptual tasks (perceived reachability and object size).

Method

Participants

Sixty-one students from the University of Virginia community, age range 18-21 (mean = 18.83, SD = 0.98), participated in Experiment 2c either for course credit or $15.00. Eight participants were excluded due to experimenter error in following procedures, four participants were excluded due to failure to follow instructions for the dependent measures, two participants were excluding for having dependent measures more than 2.5 standard deviations away from the mean, and one participant was excluded for guessing the study hypothesis, for a total of 47 participants (39 women).

Stimulus

Distance Estimation. A long hallway outside of the experiment room was used to obtain distance estimates. Two sets of three distances each were inconspicuously marked with a black marker on the hallway floor and baseboards. Set A consisted of 9, 11, and 13 meters, and Set B consisted of 10, 11, and 12 meters. There were also two different marked starting points, A and B; starting point B was off-set from A by .5 meters.

Reach Estimations. Estimations were given at a square table covered with a green felt cloth. A small, red square chip with a dot in the middle was used to obtain estimates, and a small dot on the edge of the table closest to the participant's midsection marked the reference point for all measurements.

Block Size Estimation. Estimations were given at the same felt-covered table (see Reach Estimations, above). The blocks consisted of four red square blocks, 2, 4, 6, and 8 inches in diameter, that were randomly placed in the center of the table.

Materials

Imagery task. The same imagery task from Experiment 1 was used.

Individual Differences Questionnaires. The same Extroversion Questionnaire, Experiences in Close Relationships Revised, Mood and Manipulation Check, and Demographics Questionnaire from Experiment 1 were used (see Appendices B-D for copies of the questionnaires).

Design

Participants were randomly assigned to one of three social support conditions, Positive, Neutral, and Negative. In the Positive condition, participants imagined a close, supportive friend; in the Negative condition they imagined someone who used to be a friend but had betrayed or let them down somehow; and finally, in the Neutral condition participants were imagined someone with whom they were familiar but did not know well, such as a store clerk. The study was double-blind, and there were three repeated-measures dependent variables: distance estimations, reaching ability, and block size. The distance estimation task consisted of a baseline and post-manipulation estimates of three distances each. Participants gave two reaching ability estimates, and four estimates of block size. The repeated measures within each dependent measure were randomized, and the order in which the participants completed the dependent measures following the social support manipulation was also randomized across participants.

Procedure

In an effort to reduce the number of participants that guessed the hypothesis, participants were told that they would be completing a series of different studies, one asking them to do a visualization task and a study asking for estimations in the environment. After consenting, participants first gave a baseline set of three distance estimations using a distance bisection task (Zadra, 2013). Participants were randomly and independently assigned to the starting point and the distance set. After lining up their toes with the starting point, participants closed their eyes while the experiment placed a small orange traffic cone at the target distance. Once the experimenter walked back to stand beside the participant, participants were told to open their eyes and pick a spot on the hallway floor that was halfway between the tip of their toes and the front of the traffic cone. Once the participant verbally confirmed they had done so, the experimenter walked backwards and placed a cone on the perceived halfway point. The participants were encouraged to make adjustments to the cone placement if needed. Once they were satisfied with the cone placement, they turned 180 degrees and lined their heels up with the starting line. The experimenter then used a laser distance meter to measure the estimated halfway point. This procedure was repeated for each distance estimate.

Following the baseline distance estimation task, participants were taken inside and seated at a small table adjacent a window to perform the visualization task. In order to keep the experiment double-blind, a separate spreadsheet had been created with the condition assignments for each participant. At this point in the study, the experimenter checked the spreadsheet to determine which audio file, ambiguously named A, B, and C, the participant was assigned. The conditions were written in white font so that the experimenter was not exposed to future condition assignments. They selected the appropriate audio file on the iPad, had the participants put on the headphones, and waited across the room for the task to be completed.

Again, the order of the dependent measures following the visualization task was randomized across participants. For the post-manipulation distance estimates, participants were told “I am so sorry, but it looks like I made a mistake and had you do the wrong distance estimates. I am terribly sorry, would you mind doing the estimates again?” No participants ever refused to complete the distance task a second time. Participants estimated whichever set of distances not completed previously, from the alternate starting point.

The reaching task was modeled on previous work by Linkenauger, Witt, Stefanucci, Bakdash, & Proffitt (2009). So as to limit any feedback regarding their actual reach ability, participants were instructed to take care to not put their hands over the table, ever. Once seated, participants were moved their chair as close to the table as was comfortable. In order to ensure that no one leaned forward during the estimation task, the experimenters clipped the participants’ shirts to the back of the chair. Participants gave two reach estimations, near and far. For the near estimate, the experimenters placed a small square chip on the edge of the table closet to the participant, and slowly slide it away and vice versa for the far estimate. Participants were told to stop the experimenter when they felt they could just reach out and pick up the chip on the table. The experimenter gave the participant the opportunity to make adjustments to the estimates, and then closed their eyes while the experimenter measured the distance from the center of the chip to the reference dot on the edge of the table. After the two reaching estimates were taken, experimenters measured participants’ actual reach by placing their dominant hand on the table as far as they could reach. The actual reach measurement was taken from the middle finger to the reference dot on the table.

The block estimation task was adapted from Linkenauger et al. (2014). During the block estimation task, participants sat at the same table, seated as close as was comfortable, and were unclipped from the back of the chair. The experimenter stood at a 90 degree angle to the right of the participants, holding a retractable tape measure. The participants closed their eyes while the experimenter placed a block in the center of the table. Participants opened their eyes and were told to look at the diameter of the block, and, looking back and forth as much as they would like, match the length of the diameter of the block to the length of the tape measure. With the blank side of the tape measure facing the participant, the experimenter slowly pulled out the tape measure until the participant instructed them to stop. The experimenter offered to make adjustments, and recorded a final answer. This procedure was repeated for each of the four randomized blocks.

Following the three dependent measures, participants sat a table and answered the individual differences questionnaires. Afterwards, participants were asked to guess the study hypothesis, debriefed, and thanked for their participation.

Results and Discussion

All dependent measures were first turned into ratio scores by dividing the perceived value by the actual value, creating a pre- and post- manipulation estimates of small, medium, and large distances, four block size estimates, and two reach estimates. For both pre- and post-distance ratios, a repeated measures ANOVA revealed there were no significant differences between the ratios for the short, medium, and long distances (both *p's* > .073), so the estimates were averaged to create a single pre- and post-ratio score. The average ratio for the pre-distances was 1.02 (SD = 0.09), while the average ratio for the post-distances was 1.04 (SD = 0.09). The average pre-distance ratio was marginally significantly larger than the average post-distance ratio, $t(46) = -1.97$, $p = .055$, see Figure 4.1, below.

Since previous estimates for block size and reaching estimates are more likely to be remembered and repeated, these measures were only gathered following the social support manipulation. A repeated measures ANOVA on the ratio scores for each estimated block size indicated that there were no significant difference between the four ratio scores for block size (F (4,43) = 1.64, $p = .183$), so the ratios were averaged together to create a signal score for block size (M = 1.02, SD = 0.08), which was not significantly different from 1.00 ($t(45) = 1.96$, $p = .056$). Finally, a paired-sample t test indicated that participants gave significantly smaller reach estimates when the target chip started near (M = 0.98, SD = 0.12) than when the target chip started farther away (M = 1.02, SD = 0.11, $t(45) = -3.28$, $p = .002$. The reaching ratios were also averaged to create a single reach estimate (M = 1.00, SD = 0.10), which was not significantly different than 1.00, $t(46) = 0.098$, $p = .923$. See Figure 4.1 for a graph of the perceptual measures.

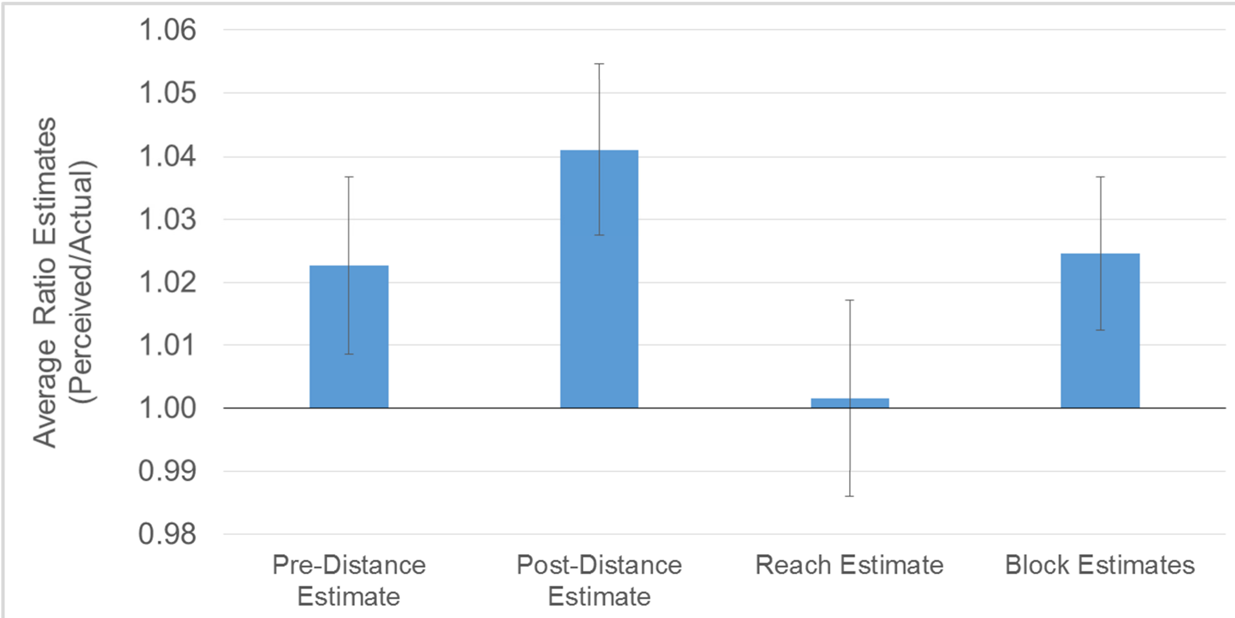


Figure 4.1. The dependent measure scores. A score of 1 indicates the participant's estimate was accurate, a score greater than 1 indicates the participant overestimated, and a score less than one indicates the participant underestimated. Error bars are +/- SE.

First, a visual inspection of the pre- and post-manipulation distance estimates revealed a marginally significant main effect of condition for the pre-manipulation distance estimates such that those in the Negative condition perceived targets to be farther away than those in the Neutral condition (F (2,42) = 3.17, p = .052, η_p^2 = .13), see Figure 4.2 below.

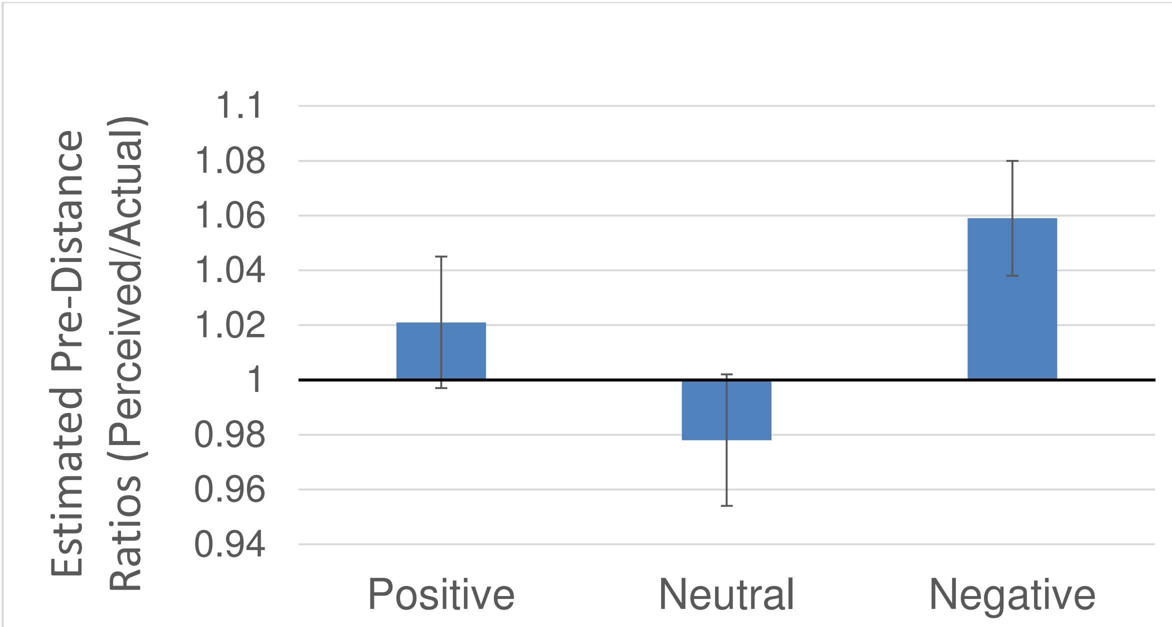


Figure 4.2. The effect of social support on pre- manipulation distance estimates, where a score of 1 indicates accurate perception of target distance. Across the three pre-distance estimates, those in the negative condition perceived targets to be farther than those in the positive condition. At the time both participants and experimenters were unaware of condition assignment. Error bars are +/- 1 SEM.

Given that the study was double-blind, this result must be due to either an extraneous factor or pre-existing, unmeasured individual differences. As a solution to the condition differences for the pre-manipulation distances, a regression was run to predict post-manipulation distance estimates from pre-manipulation distance estimates, and the residual error in the model was saved as a variable. Thus, a simple regression predicting the average post-manipulation distance ratio was predicted from the average pre-manipulation ratio; the average pre-manipulation ratio was a significant predictor of the average post-manipulation ratio, $F(1,45) = 66.73$, $p <.001$, $\eta^2_p = 0.60$. The error variables from this regression were then entered as a covariate in the following model predicting post-manipulation distance estimates, thereby controlling for group effects at baseline.

In order to investigate the effect of social support across different perceptual estimates, a multivariate ANOVA (MANOVA) with Type 1 Sum of Squares was used, which allows for variables to be correlated without assuming a strict repeated measures approach. The MANOVA had the average ratio score of block estimates, average ratio score of reach estimates, and average ratio of post-manipulation distance estimates as the dependent measures, with condition and gender as between-subject factors, and the standardized residuals when predicting post-estimates from pre-estimates as a covariate. An a priori power analyses conducted with the statistical package software G Power 3.1 revealed that, with a sample size of 46, the power to detect a medium effect size was 72%. As hypothesized, the results revealed no statistically significant main effect of condition across the three perceptual measures, $F\ (6,80) = 1.26$, $p = .283$ (observed power 47%).

Follow-up univariate ANOVA tests revealed a marginally significant effect of condition on distance estimates, $F\ (2, 41) = 3.18$, $p = .052$, $\eta_p^2 = .13$ (observed power = 58%); those in the Negative condition (M = 1.07, SE = 0.20) estimated target distances to be farther than those in the Neutral condition (M = 1.01, SE = 0.21), but not farther than the Positive condition (M = 1.04, SE = 0.20). While the Positive and Negative conditions were not significantly different from each other, these findings are consistent with Experiment 1's results investigating the effect of social support on slant estimates; in Experiment 1 there is no difference between the Neutral and Positive conditions, rather, the slant estimates in the Negative condition are higher than those in the Positive condition. This finding is also consistent with Social Baseline Theory, which asserts that an individual's default is to assume social support (Coan & Beckes, 2011; Coan & Beckes, 2012; Coan et al., 2014); thus, the Positive and Neutral social support conditions are roughly equivalent.

There was no significant effect of condition on either block size estimates, *F* (2, 41) = 0.43, *p* = .629, or reach estimates, *F* (2, 41) = 0.12, *p* = .892. There was a significant main effect of gender on reach estimates, *F* (1, 41) = 4.45, *p* = .041, η_p^2 = .10, such that men were more likely to underestimate their reach (M = 0.93, SE = 0.04) compared to women (M = 1.02, SE = 0.02). See Figure 4.3 for a graph of all dependent measures by condition.

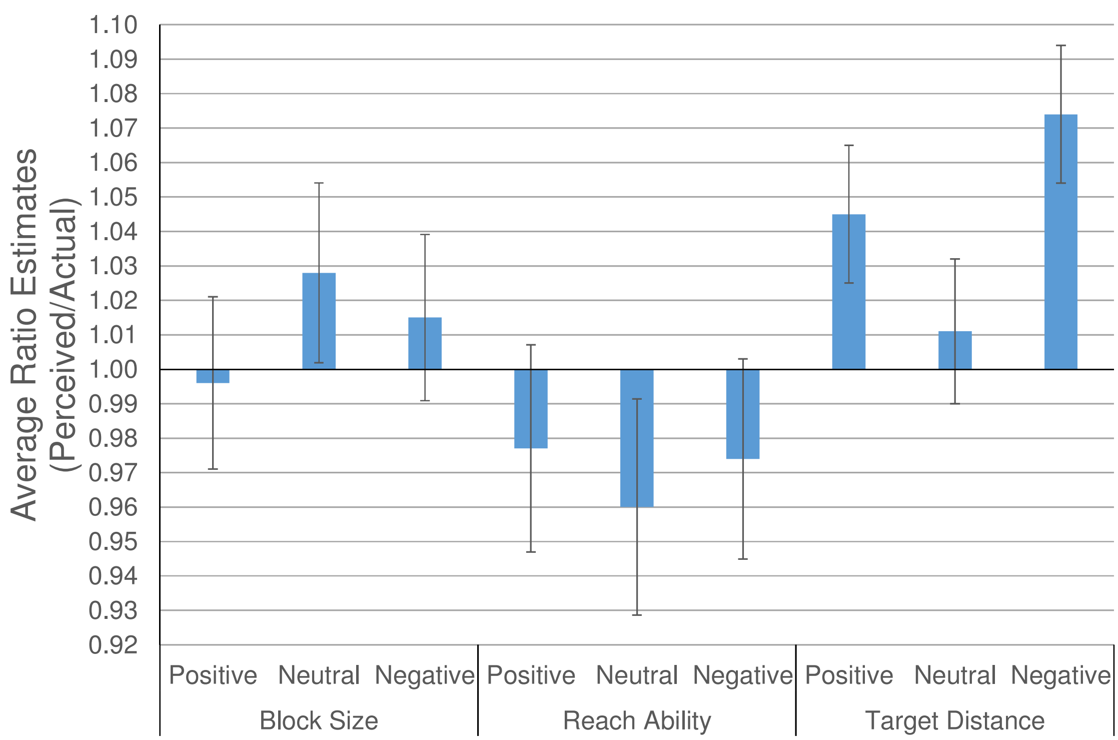


Figure 4.3. A graph of all dependent measures by condition, where a score of 1.00 (represented by black line) indicates the perceived perceptual estimate was no different than actual estimate. There was no effect of social support on either perceived block size or perceived reach ability, but there was an effect on perceived target distance such that those in the negative condition estimated the distance to be farther than those in the neutral condition. Error bars are +/- 1 SEM.

This study aim was to investigate the effect of social support across different perceptual estimates, and the results suggest that social support does not universally affect all aspects of visual perception. If social support functions via a general mechanism that alters beliefs regarding our ability to act in the world, all actions should have appeared easier, and there should have been a general effect of condition across the different perceptual estimates. Instead, as hypothesized, the effects of social support on visual perception were confined to estimates of target distance, and do not extend to either size perception or reach ability. To date, social support has only been shown to alter distance perception (present study, Meager & Marsh, 2014) and slant perception (Schnall et al, 2008). Previous work demonstrates that both slant and distance perception are scaled to the physiological effort (Proffitt & Linkenauger, 2013; Proffitt, 2006, Schnall et al., 2010), and, given that social support can also prevent further physiological depletion (Experiments 2a and 2b), it stands to reason that perhaps social support functions to change perception by signaling additional available physiological resources. Admittedly, a large number of participants were excluded from the study due to experimenter error, and so the a priori power to detect an effect (72%) was lower than the standard 80%; as such, the study will be replicated before submitting for publication.

5. Experiment 4: Social Predictors of Visual Judgments

Study Overview

Previous research suggests that social support consists of a variety of different factors. First, social support has been conceptualized as being comprised of inter-personal and intra-personal attributes (Harber, Einev-Cohen & Lang, 2008). Inter-personal attributes refer to both the structure of the social network, such as the number of strong, close ties or distant, weak ties with others, and the actual and perceived social support from the social network (Cohen, Gottlieb & Underwood, 2000). Intra-personal attributes are the changes within the self that directly result from social support. For example, social support could create changes in the individual's mood (Aspinwall, 1998), sense of self-esteem, or self-worth (Steele, 1998).

Thus far, research on social influences in visual perception has operationalized the acquisition of social resources as imagining supportive friends or inducing felt understanding between strangers (Schnall et al., 2008; Oishi et al., 2013, respectively). Also, individual differences in how others relate to their social network, such as extraversion and attachment style (Experiments 1-3) can amplify the effects of social resources on visual perception. However, based on the current research on social support and perception it is unclear exactly what aspects of the social environment (inter-personal or intra-personal attributes) are social resources by which perception is scaled. Experiment 4 addressed this issue by administering several social support questionnaires and personality style inventories in conjunction with a visual estimation task in order to determine which factors of social support are relevant for perception. Slant perception was chosen as the dependent measure largely because slant perception would be easier to determine in online picture format than distance perception, and the effect of social support on slant perception has been documented numerous times (Faulkner & Clore, 2012; Oishi et al., 2012; Experiment 1, Schnall et al., 2008).

Method

Participants

349 participants (191 women), age range 18-70 (mean age = 23.51, SD = 10.13), completed the online study. Participants were recruited from mTurk, an online marketplace that pays for completing surveys, and from the University of Virginia's Participant Pool system. The mTurk participants were paid $1.00 for study completion, and the University of Virginia students were granted .5 credit hour for their participation.

Materials

Imagery Task. The same imagery task from Experiments 1 and 2c was used.

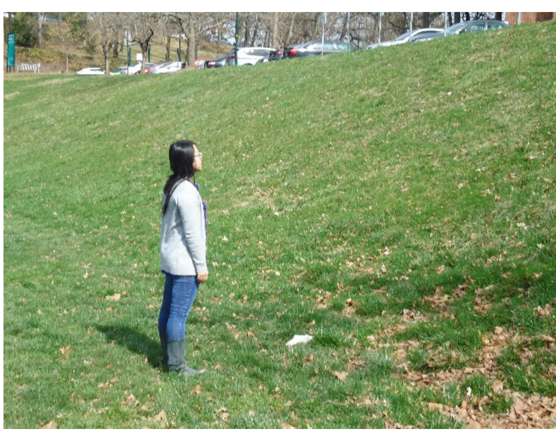
Hill Slant. Participants viewed seven pictures of various hills taken around grounds on the University of Virginia and in the larger Charlottesville community. All pictures showed the base and top of the hill, and had a person facing the hill as a reference (see Figure 5.1, below).

Bonnycastle

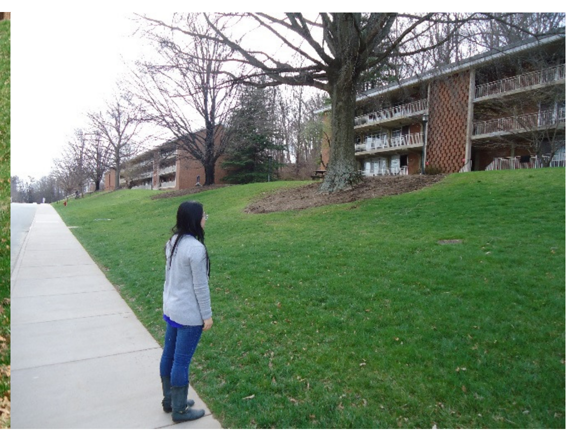
New Dorms

Bookstore Hill

Lambeth



Nameless Field



New Dorms (b)

Rugby Road Gilmer Hall - Practice

Figure 5.1. The hill slant stimuli set used in Experiment 3, with the name of each hill below. The right, bottom picture was the stimuli for the practice task.

Slant Response. Participants used a picture of a color-coded protractor to give their slant estimates (see Figure 5.2, below).

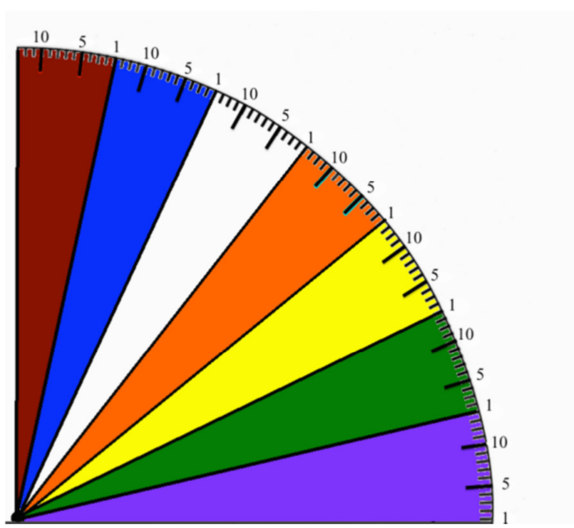


Figure 5.2. The stimuli for measuring slant estimations in Experiment 3.1.

Individual Differences Questionnaires. Participants completed a set of questionnaires to assess personality traits such as extroversion and attachment style, as well as a series of questionnaires measuring interpersonal and intrapersonal social support (see Table 5.1 for a complete list of questionnaires).

Table 5.1

A table showing the list of individual difference questionnaires.

Individual Differences Questionnaires
60-item Extraversion
Experiences in Close Relationships - Revised
Internet Social Capital Scale - Offline
Multidimensional Scale of Perceived Social Support
Interpersonal Support Evaluation List
Positive and Negative Affect Scale
Social Support Questionnaire
Demographics and Manipulation Check

Study Design and Procedure

After participants read and agreed to the informed consent, they were randomly assigned to begin with either the social support manipulation followed by the slant estimates and finally questionnaires or to begin with the individual differences questionnaires followed by the social support manipulation and hill estimates. The social support manipulation consisted of the imagery task, where participants were randomly assigned to imagine a positive, supportive friend (Positive condition), someone they were familiar with but did not know well (Neutral), or someone that used to be a friend but had betrayed them (Negative). Participants were asked before the start of the study to bring plug-in headphones. The manipulation consisted of a clickable link in the text of the online survey that automatically opened a new webpage and played the appropriate audio file.

Next, participants were oriented to the visual estimation procedure. They were shown an example picture (Figure 5.1 above, bottom right picture), and asked to imagine that they were standing in the same position as the person in the photo, at the bottom of the hill. They were then shown the response stimuli, and told to pick the color and number that corresponded to the estimated slant of the hill. On the next page of the survey, they were given the following example (Figure 5.3 below). In this example, participants were told that if the participant sees the hill as corresponding to the black line in the above figure, they would answer “Yellow 11”.

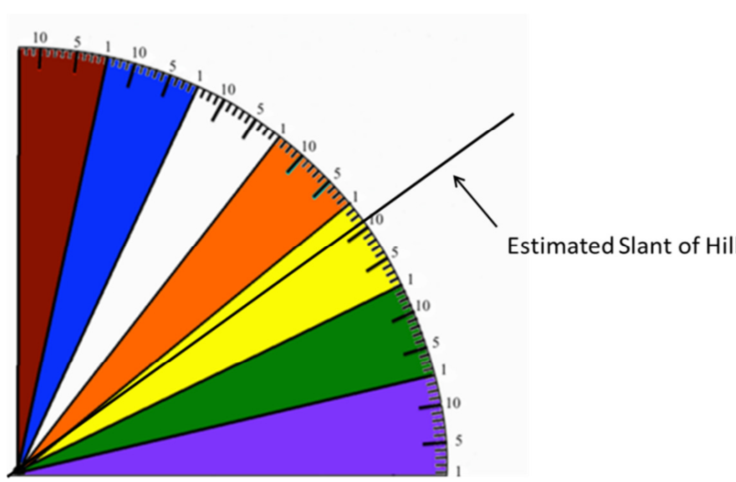


Figure 5.3. An example of how participants choose a response option to estimate, visually, the slant of a picture of a hill.

Finally, to check for understanding, participants were given a practice response option, below (Figure 5.4), where they were told to imagine that they perceived the slant of the hill to correspond to black line, and give the correct answer (Orange 3). They were not allowed to continue in the study until they entered the correct response option. Participants then viewed and visually estimated the slant of seven hills presented randomly.

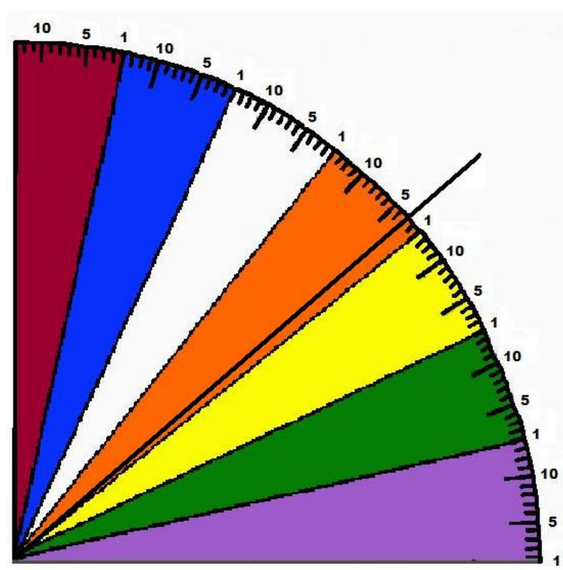


Figure 5.4. The practice stimuli to check for understanding of the visual hill estimation task.

Following the visual estimation, participants were again randomly presented with all stimuli and asked to give a verbal estimation of slant by typing a numerical answer to:

"In the picture, how steep is the hill that the person is facing, in degrees, with 0 degrees being perfectly flat and 90 degrees being a vertical wall?" Immediately following the hill estimates, participants answered the mood and manipulation check questionnaires. If participants had not previously done so, they then answered the battery of randomly presented individual difference questionnaires. Upon survey completion, participants were thanked and given a debrief form to read.

Results and Discussion

After listening to the recording, participants had to click an option affirming that they had listened to the entire audio file; one hundred fifteen (33.0%) participants indicated that they had not listened to the audio file. These participants were kept in the data analysis as a control group, for a total of four conditions: Negative, Neutral, Control, and Positive. A manipulation check revealed that the imagery task was effective ($F(3, 337) = 7.289$, $p < .001$). Those in the Negative condition reported imagining less Positive (M = 2.79, SD = 1.14) thoughts than any other condition, those in the Positive condition reported imagining more Positive thoughts (M = 3.56, SD = 1.07) than any other condition, while those in Neutral and Control condition did not differ ($M_{Neutral} = 3.27$, $SD_{Neutral} = 0.93$; $M_{Control} = 3.15$, $SD_{Control} = 0.88$).

The visual and verbal estimates for each hill were highly correlated, which suggests participants understood and correctly performed the visual estimation task. Additionally, participants on average overestimated the slant of five of the seven hills, and the degree of overestimation is consistent with that previously published in the literature (Proffitt et al., 1995). Two hills were not consistently overestimated (New

Dorms and New Dorms (b)) and were subsequently dropped from any further analyses (see Table 4.2).

Table 4.2

*The visual and verbal estimates for each hill, including previously published in-person estimates from Proffitt et al., 1995. The bolded hills were dropped from data analysis due to a lack of overestimation. * denotes significance at the p <.001 level.*

Hill Name	Actual Slant of Hill	Average Verbal Estimate	Average Visual Estimate	Correlation between Estimates
New Dorms (b)	**16**	**16.16**	**13.49**	**.229***
Nameless Field	18	54.89	44.17	.413*
Lambeth	19	58.56	49.01	.283*
Rugby Road	20	52.15	41.37	.289*
Bonnycastle	21	45.43	37.45	.366*
New Dorms	**21**	**18.11**	**18.10**	**.299***
Bookstore Hill	26	58.22	49.05	.272*

For the data analysis, all hill estimates were converted to a ratio estimate where the participant's estimate was divided by the measured slant of the hill. All dependent measures, measures of social support, attachment style, and extraversion measures were also mean-centered, and a confirmatory factor analysis was conducted to test whether the social support measures fit a model with three latent factors, perceived social support, social capital, and intrapersonal support, and one second-order interpersonal factor. The model structure was defined a priori in accordance with previous research regarding each scales' intended purpose (Harber et al., 2008; Cohen et al., 2000; Aspinwall, 1998; Steele, 1998). The confirmatory factor index (CFI) suggested that the factor structure was a good fit (CFI = .95, Hu & Bentler, 1999). These results suggest that the social support measures did load onto three unique factors: perceived social support, social capital, and intrapersonal support, see Figure 5.5.

The aim of the current study was to test the effect of separate social support constructs on hills estimates. To do so, a latent hill estimate variable was created from centered ratios of the visual hill estimates and a structural equation model was built predicting the latent hill estimate variable from the social capital variable, latent perceived social support variable, latent intrapersonal support variable, and from the dummy-coded observed condition and gender variables. See Figure 5.6, below, for a graphical representation of the final tested model. Compared to the independent model, the proposed model structure was not a good fit (CFI = .54) and none of the variables were significant predictors of the latent hill estimates.

As a follow-up, all of the hill ratio estimates were entered into a repeated-measures ANOVA with gender, condition, and questionnaire order as factors. Gender was the only significant predictor of hill estimates, F (1, 325) = 12.36, $p < .001$, $\eta^2_p = .03$ (observed power 92%); men's ratio slant estimates (M = 2.06, SD = 0.04) were less steep than women's ratio slant estimates (M = 2.24, SD = 0.04), see Figure 5.7 below. Consistent with previous work (Bhalla & Proffitt, 1995), men estimated the hills to be less steep than women. No other individual differences were significant predictors of hill estimates.

The study aim was to collect a variety of social support measures from a large number of participants in order to determine which aspects of social support and social networks were strong predictors of visual perception. The current results do not replicate the effect of social support on slant judgments or extend the previous findings regarding individual differences in extraversion or attachment style. A concern is that the null results are due to a lack of ecological validity; viewing small pictures on a computer screen do not afford acting. However, the current study's hill estimates are consistent with those of previously published work and the study replicated gender effects on slant estimates where women overestimated the slant of hills relative to men. The similarities between these results and previously published results (Bhalla & Proffitt, 1995) suggest that perhaps the task was not completely lacking in ecological validity.

An alternative possibility is that the lack of findings regarding social support is due specifically to the lack of social context. Perhaps, like physiological resources, relevancy matters. It is possible that, even when prompted to imagine supportive others, social resources are not germane when participants are performing a task on a computer, alone. This would suggest that social resources and individual differences in how we relate to our social network are only relevant to visual perception in the surrounding context of a social environment. Of course, this assertion could be easily tested in future research by having participants complete the same study while situated in a lab setting.

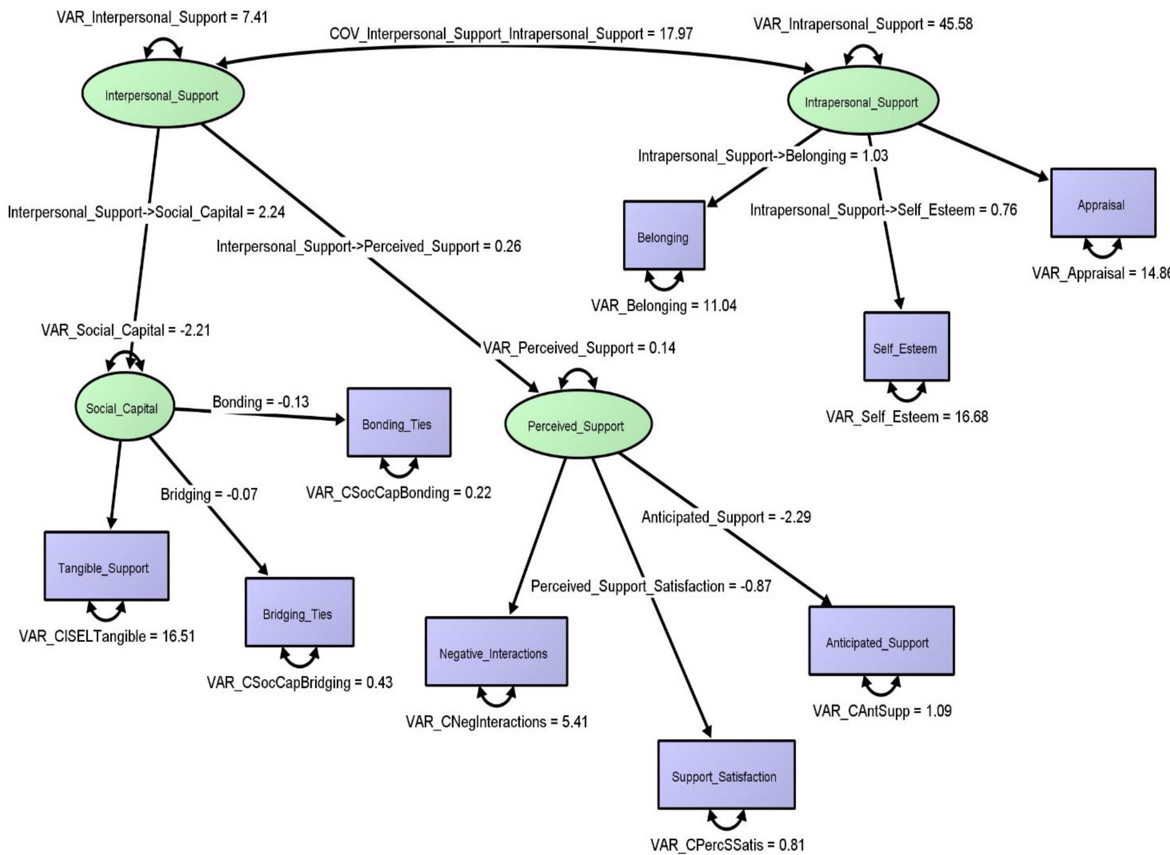


Figure 5.5. The proposed social support factor structure. The blue rectangles represent observed social support variables, and the green circles represent the latent factors on which each variable loads. A confirmatory factor analysis indicates that the proposed structure is a good fit of the data (CFI = .95).

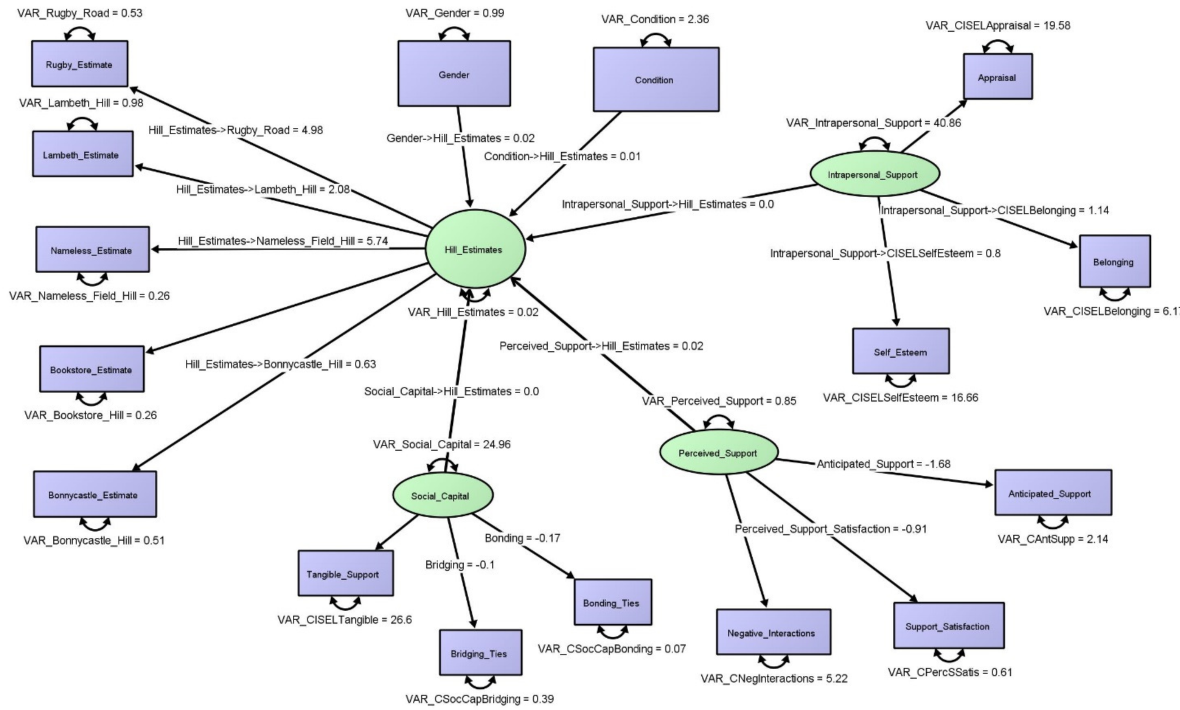


Figure 5.6. A path diagram of the structural equation model tested. The blue boxes represent observed variables and the green circles represent latent factors. The factor loadings are written on the appropriate path connecting the variables. The model was not a good fit of the data (CFI = .54), and none of the factor loadings on hill estimates approached significance.

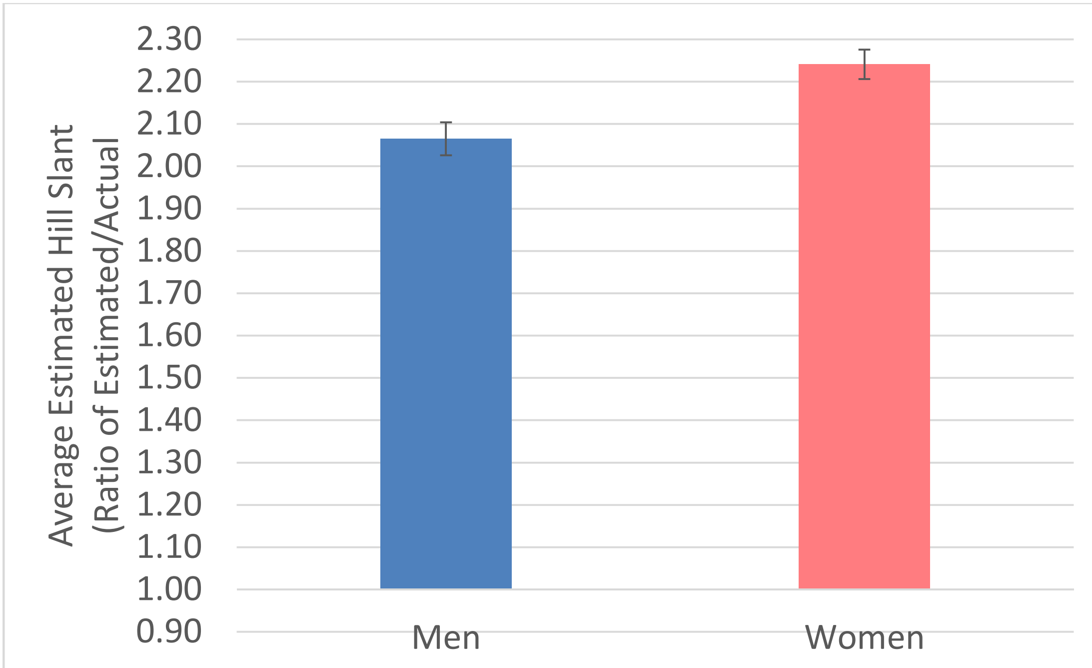


Figure 5.7. The effect of gender on hill estimates. A score of 1 (black line) indicates that the hill slant was estimated accurately. On average, men estimated the hills to be less steep than women. Error bars +/- 1 SEM.

6. General Discussion

6.1 Summary of Studies

The aims of this dissertation were to further investigate how social resources function to affect visual perception and how individual differences modify the resource costs and benefits that derive from social support. The results support two generalizations that speak to these aims. First, social resources interact with both individual differences and variability in the surrounding social environment to produce changes in visual perception. Second, the perceptual effects of social resources likely occur via signaling the availability of physiological resources.

Experiment 1 replicated the effect of social support on slant perception (Schnall et al., 2008) and investigated the role of individual differences in extraversion. Participants gave slant estimates after imagining a supportive friend, a neutral person, or someone who had betrayed them. Imagining positive social support resulted in less steep hill estimates while imagining betrayal resulted in steeper hill estimates; each of these main effects were amplified for those high in extraversion. Also, individual differences in gender interacted with social support such that there were no differences between the positive and negative conditions for men.

Study Set 2 investigated the possibility that social resources signal available physiological resources. In Experiment 2a, participants' blood glucose was measured before and after performing challenging cognitive tasks and after either holding hands with a friend, holding hands with a stranger, or sitting alone. Although the cognitive task did not result in a decrease in blood glucose levels, hand holding resulted in a rise in blood glucose, but only for individuals that were securely attached. For insecurely attached individuals, hand holding resulted in a decline in blood glucose. Experiment 2b replicated this finding. Those holding hands with friends had an overall net gain in blood glucose and the change in glucose was positively related to attachment security such that secure individuals had a higher gain in blood glucose, but insecure individuals experienced a drop. For these two studies, supportive physical touch resulted in a change in physiological resources.

Additionally, if social resources are signaling available physiological resources, then the effects of social support should not extend to perceptual estimates that are not scaled to physiological resources. In Experiment 3, participants underwent a social support manipulation and then gave three different measures of visual perception: target distance estimates, block size, and reach ability. The results showed that, indeed, negative social support resulted in overestimation of distances, but did not affect either estimated block size or estimated reaching ability. Together, Study Set 2 and Experiment 3 suggests that social support alters visual perception by signaling the availability of, or lack of, physiological resources.

Thus far, social support in the context of visual perception has been broadly defined, and so Experiment 4 was a large online study designed to identify which unique factors of social support are contributing to effects on slant estimates. There was an effect of gender such that men gave lower slant estimates than women but, unfortunately, there was no effect of either the social support manipulation or individual differences on slant estimates. These could be due to the use of pictures, which do not afford action, or to the lack of social context in the experiment.

6.2 Interactions between Individual Differences and Social Environment

The current set of studies replicated the effects of social support on visual perception. Overall, participants in a negative social support condition gave higher slant estimates and estimated target distances to be farther away, compared to those in neutral or positive social support conditions. This suggests that the visual perception system is sensitive to social resources; when social resources are high, the cost of acting in the environment is decreased and so slants appear shallower and target distances appear closer.

However, previous literature in social support and health has found that the benefits of social support are not ubiquitous. Social baseline theory asserts that the individual's default is to assume a social network (Beckes & Coan, 2011) but this is surely subject to individual differences. For example, those high in extraversion have larger support networks (Stokes, 1985; Cohen et al., 1997; Swickert et al., 2002) from which they are more likely to seek support (Amirkhan et al., 1995; Halamandaris & Power; 1995). Likewise, securely attached individuals assess others in their social networks to be more reliable and dependable than insecurely attached individuals (Ainsworth et al., 1978; Bartholomew & Horowitz, 1991). That is, extroverts and securely attached individuals have a higher social baseline because they are more connected to their social networks.

Furthermore, when directly provided with social support, extraverts and securely attached individuals will report higher perceived social support than introverts and insecurely attached individuals (Swickert et al., 2010; Collins & Feeney, 2004). The results from the current studies also demonstrated that extraverts and securely attached individuals benefited more from social support. In the positive social support conditions, extroverts reported the slants of hills to be shallower than introverts. Similarly, securely attached individuals had higher gains in blood glucose following supportive physical touch compared to insecurely attached individuals.

Thus far, conceptualizations of the social network have largely focused on the benefits, although one recent study did investigate how the potential social costs of a joint cooperation tasks affected distance estimates (Meagher & Marsh, 2014). This dissertation proposes that individual differences also interact with variations in the social environment to produce social costs. While it is known that more socially connected individuals will benefit more from a positive social environment, it also follows that these individuals will suffer a higher cost in the face of a betrayal. Indeed, in the negative support conditions, the relationship between social support and individual differences reverses directions. Now, extroverts fare worse than introverts; extraverts in the negative support condition gave steeper estimates than introverts. Perhaps most surprisingly, even a positive social support condition can interact with individual differences to function as a cost to an individual. Insecurely attached individuals faced with supportive physical touch experienced a decline in physiological resources as measured by blood glucose level.

6.3 Mechanisms behind Social Support and Visual Perception

The information for visual perception consists of changes visual angles (Gibson, 1979) that specify size and extent (Proffitt & Caudek, 2013); however the angular units of optic flow must be transformed and scaled into linear units via the application of geometry and a perceptual ruler. Current accounts in perception suggest that the body's phenotype, which consists of morphology, physiology, and behavior, is the effective perceptual ruler (Proffitt, 2006; Proffitt & Linkenauger, 2013). For hill slant and target distances, our perceptions are scaled to the physiological costs associated with walking these extents relative amount of physiological resources available. Either increasing the amount of available resources or decreasing the cost of acting results in shallower slant estimates and closer target distance estimations (Proffitt, 2006; Schnall et al., 2010; Zadra et al, in press).

Research in social support postulates that visual perception can also be scaled to social resources (Schnall et al., 2008), a finding replicated in the current set of studies. While previous research has established an effect of social resources on visual perception, a mechanism for how social resources function has yet to be established. Given that visual perception is scaled to the body's phenotype, there are two potential, but not necessarily mutually exclusive, alternatives. Social resources could lower the cost of acting in the environment by either signaling the availability of additional physiological resources or altering our beliefs about our general ability to act in the environment.

In the current research, two experiments demonstrated that social support does, in fact, signal available physiological resources. In Experiments 2a and 2b, supportive physical touch resulted in a net gain in blood glucose for securely attached individuals and a decline in blood glucose for insecurely attached individuals. Since previous work demonstrates that increased blood glucose does alter visual slant perception (Schnall et al., 2010, Zadra et al., in press), this suggests that the effects of social resources on slant perception could be due to an increase in a physiological resource, blood glucose.

However, this does not rule out the possibility that social support might still alter general beliefs about our ability to act.

To further test the potential mechanism, Experiment 3 examined the effect of social support on various aspects of perception: target distance estimates, block size, and perceived reach ability. If social support does alter a belief regarding our ability to act, then there should be an effect of social support across all three measures of visual perception. On the other hand, if social support functions only by signaling additional physiological resources, then the manipulation should only affect target distance estimates. Indeed, social support only affected target distance estimates such that those in the negative condition estimated target distances to be farther than those in the positive condition. These results suggest that social resources do, in fact, function by signaling additional physiological resources.

6.4 The Development of the Association between Social Support and Physiological Resources

Still, the idea that social resources signal physiological resources raises an important, unanswered question. How does social support come to represent additional physiological resources? While the current set of studies does not address this question directly, the investigation into individual differences could shed light on the issue. It seems that for social support to alter visual perception by signaling additional physiological resources, then two conditions are necessary: the body must be able to learn the relationship between social resources and physiological resources, perhaps via classical conditioning, and the visual system must be scaled to the bioenergetic costs of acting in the environment relative to the bioenergetic resources available. I have summarized compelling empirical support for the latter claim, above (Proffitt & Linkenauger, 2013; Schnall et al., 2010, Zadra et al., in press), and so I will focus on the former, classical conditioning.

In the current set of studies, the effect of supportive physical touch on blood glucose levels depends largely on attachment style, which is dependent on early life experiences with caregivers. In attachment style theory, early life experiences with reliable, dependable caregivers whom are sensitive to infants' and children's physiological needs will translate to a secure attachment style (Ainsworth et al., 1978). That is, securely attached adults have had a lifetime of experience where interactions with caregivers literally translate into being given body warmth and being fed when hungry, both of which reduce the demand for physiological resources. Through classical condition, a securely attached individual could quickly associate the presence of others with a reduced physiological load. In a feed-forward mechanism, a reduced anticipatory physiological load allows for the body to release stored glucose back into the blood stream in an effort to restore blood glucose levels to baseline. In fact, it is only in securely attached adults (Experiments 2a and 2b) that I find the relationship where supportive physical touch resulted in increases in blood glucose. On the other hand, insecurely attached individuals have had a lifetime of inconsistent experiences with caregivers and have internalized the belief that others are unreliable. In this case, social contact engenders an anticipatory potential cost to the individual, and so it would be beneficial for a feed forward mechanism to conserve resources for future use by taking glucose out of the bloodstream. Alternatively, social contact may induce stress that increases the metabolic demand for blood glucose. Indeed, the blood glucose of insecurely attached individuals declines during hand holding.

It stands to reason, then, that the effects of social support on visual perception could be an emergent property of perception that manifests when a simple learning principle, classical condition, is placed in the appropriate complex social environment. Without the appropriate past experiences needed to learn the association between social resources and physiological resources or the appropriate current social environment to elicit the effect, there would be no effect of social support on visual perception.

6.5 Summary

The current studies provide support for two claims. First, the benefits and costs in the social environment interact with individual differences in social connectedness to differentially affect visual perceptual estimates; compared to introverts and insecurely attached individuals, extroverts and securely attached individuals benefited more from social support but incur a higher cost in the face of a betrayal, and, compared to securely attached individuals, insecure individuals suffered a higher cost in the presence of social support. Second, social support likely functions to alter visual perception by signaling the availability of additional physiological resources, and not by altering a general belief about one's ability to act in the environment.

6.6 Conclusions

In the current paper, I presented the argument that perception needs to be scaled to a ruler, and follow with a review of the empirical evidence that perception is scaled to the body's morphology, physiological resources, and behavioral repertoire, as well as to social costs and resources. I then reviewed the idea of a physiological baseline, and claimed that social baselines vary with individual differences in social connectedness, namely, attachment style and extroversion. Through the current experiments, I found that individual differences interact with social support such that a predisposition to rely on social networks results in either an added cost or benefit, depending on the interaction between the individual difference and current social environment.

Next, I hypothesized that the mechanism behind the effect of social support on visual perception is a change in potential physiological resources. I presented evidence that social support resulted in a net increase in blood glucose, but only for securely attached individuals. For insecurely attached individuals, social support resulted in a loss of physiological resources, blood glucose. I also discovered that the effect of social support is specific to distance and slant perception, which are typically scaled to physiological resources, and not to reaching ability and block size, which are scaled to morphology. Finally, there was no effect of social support or individual differences in a large, online study of hill estimates, which could be due to either the use of small pictures that do not afford acting or to the lack of social context.

In sum, these findings highlight the importance of considering the ecological environment in which humans are situated. Humans are inherently social animals, and filling these gaps in the literature is a vital next step in understanding how our visual system operates and how the social environment interacts with basic cognitive processes.

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Appendix A: Imagery Scripts

Schnall, S., Harber, K. D., Stefanucci, J. K., & Proffitt, D. R. (2008). Social support and the perception of geographical slant. *Journal of Experimental Social Psychology, 44*(5), 1246-1255. doi:10.1016/j.jesp.2008.04.011

Positive Imagery Condition (as recorded on Macintosh Computer by Joseph Tan)

This is the imaging and visual judgment study. We are interested in how the processes of mental imagery relate to other visual processes. The study involves two parts. In the first part, you will generate images about a person or event in your own life. In the second part you will participate in a visual judgment task. Before we begin, a word about privacy and confidentiality. In this study, we do not collect any information regarding your identity, such as your name, or student ID. Your privacy, and the confidentiality of your responses are 100% in this study.

Part one, imaging task. You will be asked to create images from some event in your life. I will suggest some topic for you to image, and your job will be to create as full and complete an image of it as possible. First I'll have you just relax, to make it easier for you to create images, then I will ask you to image a few scenes from your own life. OK, let's begin.

Relaxation. Let's start by having you just relax. You might want to settle back into a comfortable position in your chair. For a minute or so, just let all the worries of the day go. Let your mind go blank, let the tensions seep away. Let your body relax. Let yourself get into a quiet state, close your eyes and stay there. In a minute, we will go on to the next part.

Imaging someone close. Now let's move on to the imaging task itself. Think of someone who is very important to you. This is someone who you like very much, and makes you feel warm and good when you are around them. This is someone you can trust, and who would definitely help out if you needed them to do so. Take a few moments and just think about this person, and why you like them, and how they make you feel. Try to picture this person, and try to picture being with this person as you think about him or her. In about 30 seconds we'll move on to the next part.

Imaging this person being there for you. Now think of the time, where this person who you have been thinking about really made you feel especially safe, secure or appreciated. What exactly did this person do? How did you feel about yourself? Go ahead and think about this. In about 30 seconds we will move on to the next part.

Take a few moments, to focus more intently on this person and the way he or she looked on that day where they were really there for you. See this person's face in front of you as if it were that day, recall their voice and what they said. In about 30 seconds we will go on to the next part.

Finally, just focus on those images that are associated with your strongest thoughts and feelings about this person, and the time when they were there for you. Take a few moments, and just let yourself feel as if the situation were happening to you right now. What are the images that come up? Focus on these and how they make you feel.

This ends the imaging part of the study. Please turn off the tape player, and signal to the experimenter that you are done. Thank you.

Negative Imagery Condition (as recorded on Macintosh Computer by Joseph Tan)

This is the imaging and visual judgment study. We are interested in how the processes of mental imagery relate to other visual processes. The study involves two parts. In the first part, you will generate images about a person or event in your own life. In the second part you will participate in a visual judgment task. Before we begin, a word about privacy and confidentiality. In this study, we do not collect any information regarding your identity, such as your name, or student ID. Your privacy, and the confidentiality of your responses are 100% in this study.

Part one, imaging task. You will be asked to create images from some event in your life. I will suggest some topic for you to image, and your job will be to create as full and complete an image of it as possible. First I'll have you just relax, to make it easier for you to create images, then I will ask you to image a few scenes from your own life. OK, let's begin.

Relaxation. Let's start by having you just relax. You might want to settle back into a comfortable position in your chair. For a minute or so, just let all the worries of the day go. Let your mind go blank, let the tensions seep away. Let your body relax. Let yourself get into a quiet state, close your eyes and stay there. In a minute, we will go on to the next part.

Imaging someone who let you down. Now let's move on to the imaging task itself. Think of someone who in the past who was important to you, but who really disappointed you in a very big way. This is someone who let you down when you really needed their help or betrayed your trust. This is somebody who you once liked, but do not like now. They make you uncomfortable when you see them. Take a few moments and think about this person, what they did, and how you feel about them. Try to picture this person as you think about him or her. In about 30 seconds we'll move on to the next part.

Imaging this person and feeling let down. Now think of the time, where this person failed to help you, betrayed your trust, or made a difficult situation worse. What did this person do that was disappointing? Take a few moments now, think back on the facts of the situation, where you were with this person when this was going on, and the way this person treated you. Go ahead and think about this. In about 30 seconds we will go on to the next part.

Take a few moments, to focus more intently on this person and the way he or she looked that day. See this person's face in front of you as if it were that day, recall their voice and what they said. In about 30 seconds we will go on to the next part.

Finally, just focus on those images that are associated with your strongest thoughts and feelings about this person, and the time when they let you down. Take a few moments, and just let yourself feel as if the situation were happening right now. What are the images that come up? Focus on these and how you felt. In about 30 seconds we will go on to the next part.

This ends the imaging part of the study. Please turn off the tape player, and signal to the experimenter that you are done. Thank you.

Neutral Imagery Condition (as recorded on Macintosh Computer by Joseph Tan)

This is the imaging and visual judgment study. We are interested in how the processes of mental imagery relate to other visual processes. The study involves two parts. In the first part, you will generate images about a person or event in your own life. In the second part you will participate in a visual judgment task. Before we begin, a word about privacy and confidentiality. In this study, we do not collect any information regarding your identity, such as your name, or student ID. Your privacy, and the confidentiality of your responses are 100% in this study.

Part one, imaging task. You will be asked to create images from some event in your life. I will suggest some topic for you to image, and your job will be to create as full and complete an image of it as possible. First I'll have you just relax, to make it easier for you to create images, then I will ask you to image a few scenes from your own life. OK, let's begin.

Relaxation. Let's start by having you just relax. You might want to settle back into a comfortable position in your chair. For a minute or so, just let all the worries of the day go. Let your mind go blank, let the tensions seep away. Let your body relax. Let yourself get into a quiet state, close your eyes and stay there. In a minute, we will go on to the next part.

Imaging someone you often see, but do not know. Now let's move on to the imaging task itself. Think of someone who you see every so often in their official capacity, but who you do not really know personally. This should be someone such as the store clerk at the bookstore, or at the student store, or the cashier at the food court. This is someone you feel neutral toward. You neither like, nor dislike this person. Take a few moments and think about this person, and what job they do. Try to picture this person as you think about him or her. In about 30 seconds we'll move on to the next part.

Imaging this neutral person. Now think of a time when you interacted with this neutral person. This should be a very neutral, normal encounter, neither friendly nor unfriendly, just business-like. What exactly occurred? Take a few moments and think back on the situation, and what happened. If you have never interacted with this person, just imagine what it would be like to have an interaction with him or her. I will come back in about 30 seconds to go on to the next part.

Take a few moments, to focus more intently on this person and the way he or she looks. See this person's face in front of you as if it were that day, recall their voice and what they said. In about 30 seconds we will go on to the next part.

Finally, just focus on those images that are associated with your thoughts and feelings about this neutral person and a typical interaction with him or her. Take a few moments, and see the situation as if it were happening right now. What are the images that come up? Focus on these images.

This ends the imaging part of the study. Please turn off the tape player, and signal to the experimenter that you are done. Thank you.

Appendix B: Extraversion Questionnaire

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public- domain personality measures. *Journal of Research in personality*, *40*(1), 84-96. doi:10.1016/j.jrp.2005.08.007

How Accurately Can You Describe Yourself?

Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Indicate for each statement whether it is 1. Very Inaccurate, 2.Moderately Inaccurate, 3. Neither Accurate Nor Inaccurate, 4. Moderately Accurate, or 5.Very Accurate as a description of you.

1. __________ Am always busy.
2. __________ Am willing to try anything once.
3. __________ Seek danger.
4. __________ Act wild and crazy.
5. __________ Have a lot of fun.
6. __________ Can talk others into doing things.
7. __________ Warm up quickly to others.
8. __________ Don't like to draw attention to myself.
9. __________ Dislike loud music.
10. __________ Radiate joy.
11. __________ Keep in the background.
12. __________ Hold back my opinions.
13. __________ Make friends easily.
14. __________ Prefer to be alone.
15. __________ Like to take my time.
16. __________ Love excitement.
17. __________ Seldom joke around.
18. __________ Enjoy being part of a group.
19. __________ Can manage many things at the same time.
20. __________ Talk to a lot of different people at parties.
21. __________ Love surprise parties.
22. __________ Am not really interested in others.

23. ___________ Avoid contacts with others.

24. ___________ Am not easily amused.

25. ___________ Seek to influence others.

26. ___________ Take charge.

27. ___________ Laugh aloud.

28. ___________ Seek quiet.

29. ___________ Try to lead others.

30. ___________ Enjoy being part of a loud crowd.

31. ___________ Avoid crowds.

32. ___________ Am always on the go.

33. ___________ Act comfortably with others.

34. ___________ Would never go hang gliding or bungee jumping.

35. ___________ Express childlike joy.

36. ___________ Seek adventure.

37. ___________ Enjoy being reckless.

38. ___________ Feel comfortable around people.

39. ___________ Let things proceed at their own pace.

40. ___________ Don’t like crowded events.

41. ___________ React quickly.

42. ___________ Like a leisurely lifestyle.

43. ___________ Love large parties.

44. ___________ Amuse my friends.

45. ___________ Do a lot in my spare time.

46. ___________ Love action.

47. ___________ Often feel uncomfortable around others.

48. ___________ Love life.

49. ___________ Am hard to get to know.

50. ___________ Laugh my way through life.

51. ___________ Involve others in what I’m doing.

52. ___________ Keep others at a distance.

53. ___________ Look at the bright side of life.

54. ___________ Take control of things.

55. ___________ React slowly.

56. ___________ Wait for others to lead the way.

57. ___________ Like to take it easy.

58. ___________ Cheer people up.

59. ___________ Want to be left alone.

60. ___________ Have little to say.

Appendix C: Experiences in Close Relationships Revised

Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self- report measures of adult attachment. *Journal of personality and social psychology*, *78*(2), 350. DOI: 10.1037//0022-3514.78.2.350

The statements below concern how you feel in emotionally intimate relationships. We are interested in how you generally experience relationships, not just in what is happening in a current relationship. Respond to each statement by clicking a circle to indicate how much you agree or disagree with the statement.

1) I feel comfortable depending on romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

2) My desire to be very close sometimes scares people away.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

3) I don't feel comfortable opening up to romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

4) I do not often worry about being abandoned.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

5) My partner only seems to notice me when I'm angry.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

6) It helps to turn to my romantic partner in times of need.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

6) I prefer not to show a partner how I feel deep down.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

7) I often worry that my partner will not want to stay with me.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

8) I worry that romantic partners won't care about me as much as I care about them.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

9) I rarely worry about my partner leaving me.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

10) I often worry that my partner doesn't really love me.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

11) It's easy for me to be affectionate with my partner.
Strongly Disagree Strongly Agree

1 2 3 4 5 6 7

12) I often wish that my partner's feelings for me were as strong as my feelings for him or her.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

13) It makes me mad that I don't get the affection and support I need from my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

14) Sometimes romantic partners change their feelings about me for no apparent reason.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

15) I tell my partner just about everything.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

16) I prefer not to be too close to romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

17) I find that my partner(s) don't want to get as close as I would like.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

18) I find it difficult to allow myself to depend on romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

19) When my partner is out of sight, I worry that he or she might become interested in someone else.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

20) I talk things over with my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

21) I am very comfortable being close to romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

22) I'm afraid that once a romantic partner gets to know me, he or she won't like who I really am.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

23) I get uncomfortable when a romantic partner wants to be very close.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

24) My romantic partner makes me doubt myself.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

25) My partner really understands me and my needs.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

26) I find it easy to depend on romantic partners.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

27) When I show my feelings for romantic partners, I'm afraid they will not feel the same about me.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

28) I find it relatively easy to get close to my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

29) I usually discuss my problems and concerns with my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

30) I worry a lot about my relationships.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

31) I am nervous when partners get too close to me.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

32) I worry that I won't measure up to other people.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

33) I'm afraid that I will lose my partner's love.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

34) I feel comfortable sharing my private thoughts and feelings with my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

35) It's not difficult for me to get close to my partner.
Strongly Disagree Strongly Agree
1 2 3 4 5 6 7

36) Are you male or female?
___ Female
___ Male

37) How old are you?
___ years

38) Are you married?
___ No
___ Yes

39) If you are married, how long have you been married to your partner?
___ years

Appendix D: Social Support Manipulation and Demographic Check

Schnall, S., Harber, K. D., Stefanucci, J. K., & Proffitt, D. R. (2008). Social support and the perception of geographical slant. *Journal of Experimental Social Psychology, 44*(5), 1246-1255. doi:10.1016/j.jesp.2008.04.011

PTP # _____

The following questions refer to the imagery task you completed earlier.

1. Please rate the pleasantness, on average, of the images you visualized.

1	2	3	4	5
Not at all pleasant				Very pleasant

2. Please rate the amount of disturbing content in the images you visualized.

1	2	3	4	5
Very disturbing				Not at all disturbing

This question refers to the person that you visualized during the imagery task. Please indicate the degree to which you have the following feelings towards the person you visualized on a 1 (not at all) to 5 (a great degree) scale.

___________ Closeness
___________ Warmth
___________ Happiness
___________ Neutral Regard
___________ Anger
___________ Sadness

How long have you known the person you imaged (in months)? __________

Please rate your feelings towards this person on a 1 to 5 scale where 1 indicates your feelings are not at all friendly and 5 indicates that your feelings are extremely friendly. ___________

Please indicate how likely you are to turn to the person you imaged for help with a problem, where 1 indicates not at all likely and 5 indicates that you absolutely would turn to him/her for help. _________

The following questions refer to you.

Please indicate your general physical condition, where 1 is excellent and 6 is poor ____________.

Please indicate your physical condition **today**, where 1 is excellent and 5 is very unwell ___________.

How often do you exercise per week? ___________