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Abstract

The visual perception of geographical slant is influenced by *physiological resources,* such as physical fitness, age, and being physically refreshed. In two studies we tested whether a *psychosocial resource,* social support, can also affect the visual perception of slants. Participants accompanied by a friend estimated a hill to be less steep when compared to participants who were alone (Study 1). Similarly, participants who thought of a supportive friend during an imagery task saw a hill as less steep than participants who either thought of a neutral person or a disliked person (Study 2). In both studies, the effects of social relationships on visual perception appear to be mediated by relationship quality (i.e., relationship duration, interpersonal closeness, warmth). Artifacts such as mood, social desirability, and social facilitation did not account for these effects. This research demonstrates that an interpersonal phenomenon, social support, can influence visual perception.

Keywords: Social support; psychosocial resources; closeness; relationship; slant perception; vision; space perception.

Social Support and the Perception of Geographical Slant

The visual perception of the physical world is influenced by the physical demands associated with intended actions. For example, the conscious perception of hill slants and of walking distances is influenced by whether the perceiver is wearing a heavy backpack (Proffitt, Stefanucci, Banton, & Epstein, 2003), is young or old (Bhalla & Proffitt, 1999), is fatigued (Proffitt, Bhalla, Gossweiler, & Midgett, 1995), or has action goals in mind (Witt, Proffitt, & Epstein, 2004). These physical states influence perception because they are relevant to anticipated action: A hill is harder to climb for elderly or fatigued persons, and thus appears to be steeper to them.

Perception of the physical world is therefore not determined solely by the objective features of the environment as specified by perceptual and sensorimotor variables, but is also shaped by the perceiver's capacity to purposefully negotiate physical space. When physical resources are depleted (due to age, fatigue, etc.) hills appear steeper and distances appear greater Bhalla & Proffitt, 1999; Proffitt et al., 2003). Perception therefore functions within a behavioral “economy of action” (Proffitt, 2006). To promote energetic efficiency, perception relates spatial contexts (e.g., heights, distances, gradients) to both the physical demands these contexts present and to the perceiver’s physical state. Thus, as the energetic demands of ascending hills and walking distances increase (due to a perceivers’ depleted physical resources), the perception of their incline and extent is amplified.

Psychosocial Resources and Physical Perception

Do psychosocial resources, such as social support, moderate visual perception of the physical world as do physiological resources? If so, then the physical world should appear less challenging when psychosocial resources are bolstered, and more challenging when they are depleted. In particular, hills should appear less steep when a psychosocial resource is available than when it is not. The present research tested this prediction, focusing on social support as the psychosocial resource. There are two aspects of social support that bolster this prediction. One is that support powerfully affects physiological responses to challenges, and another is that support moderates how challenges are evaluated.

Social Support Reduces Physiological Load

The notion that social support serves to physically unburden people is well established. The mere presence of another person can be beneficial, especially if this person provides support in a nonevaluative and nondirective manner (Harber, Schneider, Everard, & Fisher, 2005; Kamarck, Manuck, & Jennings, 1990). According to the buffering hypothesis (e.g., Thoits, 1986), social support promotes health by reducing physical reactivity to stress, and is therefore protective against stress-related illnesses ranging from the common cold (Cohen, Doyle, Turner, Alper, & Skoner, 2003) to heart disease (Seeman & Syme, 1987) to cancer (Fawzy et al., 1993).

Social support also alleviates proximal stressors. For example, the cardiac stress reaction created by challenging mental arithmetic tasks is smaller when a person is accompanied by a supportive other than when alone (Kamarck et al., 1990). The presence of a pet reduces cardiovascular reactivity while performing a stressful task, presumably because pets are especially nonevaluative companions (Allen, Blascovich, Tomaka, & Kelsey, 1991). The presence of conspecifics decreases stress reactions in non-humans, including rats (Davitz & Mason, 1955; Latané, 1969), guinea pigs (Hennessey, O'Leary, Hawke, & Wilson, 2002) and monkeys (Gust, Gordon, Brodie, & McClure, 1994). In sum, social support appears to "lighten the load" that individuals physically incur when facing challenging situations.

It is critical to note, however, that the benefits of social support often derive from the psychological benefits (e.g., increased feelings of competence, belongingness, efficacy, and control) rather than direct instrumental assistance from the support source. Thus, support sources did not provide solutions to mental arithmetic tasks in Kamarck et al. (1990), nor did they supply medical assistance to those exposed to cold viruses in Cohen et al. (2003). Instead, support sources in these and related studies appear to change copers' "secondary appraisal" (Lazarus & Folkman, 1984) of their own internal coping capacities.

Social Support and the Perception of Challenges

People tend to amplify their perception of negatively-arousing objects and situations (Easterbrook, 1959). For example, spiders are seen as looming closer by spider phobics (Riskind, Moore, & Bowley, 1995), time passes more slowly for newly-abstinent smokers (Klein, Corwin, & Stine, 2003), physical pain increases with pain-related anxiety (Rhudy & Meager, 2000), and disturbing objects appear physically closer than do non-disturbing objects (Matthews & Mackintosh, 2004).

If challenging objects and situations are perceptually amplified because they are negatively arousing, and if resources reduce arousal, then the perception of challenging things should be moderated when resources are bolstered. Following this logic, Harber and associates have explored the role of social support and other resources in the perception of challenging stimuli. When social support was bolstered, physical pain was perceived as less intense (Harber & Wenberg, in preparation; see also Brown, Sheffield, Leary, & Robinson, 2003), and infant cries were perceived as conveying less distress (Harber, Einav-Cohen, & Lang, in press). These effects were moderated by support-related attributes such as feeling close to the support source.

Do psychosocial resources similarly affect the manner in which the physical world is perceived? Specifically, would a physical challenge be visually perceived as more extreme under conditions of minimal or negative social support, but less extreme under conditions of positive social support? The present research was designed to test whether such shifts in visual perception would occur. Two studies employed the same judgment task—estimating the slant of a hill—that past perceptual research showed to be affected by physical burdens (Proffitt et al., 1995). If psychosocial resources, like physical resources, influence perception, then judgments of hill slant under conditions of increased social support should be less extreme than judgments made under conditions of no support (Study 1) and under conditions of depleted support (Study 2).

Study 1

Study 1 is the first study to examine whether psychosocial resources moderate vision in the same manner as physical resources. Whereas Proffitt's earlier research showed that people who enjoy the physical resources of being rested, in shape, or young saw hill slopes as less steep, Study 1 predicted that people who enjoy the psychosocial resources of being with a friendly acquaintance (compared to those alone) will similarly see hills as less steep. It did so using a quasi-experimental design that capitalized on naturally-formed social bonds.

Study 1 employed nearly identical concepts, methods, and measures to those used by Proffitt and associates in their pioneering work on physical resources and human perception. This design similarity enabled conceptual parallels between psychosocial resources of social support and physical resources. We therefore explain these design elements in detail, below.

Explicit vs. Implicit Visual Perception. Previous research shows that although people overestimate slant on explicit estimates, such as reporting the angle of slants in degrees or performing a non-verbal visual matching task, they display highly accurate estimates when assessments were made via a visually guided action such as adjusting a palmboard or a footboard by feel to a visually presented incline (Proffitt et al., 1995; Kinsella-Shaw, Shaw, & Turvey, 1992, respectively). This apparent discrepancy (exaggeration for verbal and visual matching tasks, accuracy for palmboards and footboards) may be attributable to the two functionally separate streams of cortical visual processing: One system is involved in explicit awareness and object recognition, and the other system is involved in the visual guidance of actions. These systems are associated with anatomically separate cortical tracks: explicit awareness by the *ventral stream* and visually guided action control by the *dorsal stream* (Creem & Proffitt, 2001; Milner & Goodale, 1995).

The explicit awareness aspects of visual perception are captured by a *verbal estimate*, which involves stating the slant of a hill in geometric degrees, and by *visual matching*, which involves adjusting a disk that represents the cross-section of the hill. The verbal and visual measures assess people's explicit awareness of steepness, and on these measures people tend to grossly overestimate hill slant. Visual control of action is captured by a *haptic* measure of hill slant, which involves placing the dominant hand on a palmboard that can be adjusted to be parallel to the hill's incline. This visually-guided action measure is generally accurate and uninfluenced by physical state such as age and physical fitness (Bhalla & Proffitt, 1999).

Measuring haptic perception. The distinction between the visual matching measure and the haptic palmboard warrants further discussion. The haptic palmboard measure is collected by asking participants to place their hand on the palmboard and, *without looking at the palmboard*, to adjust it to be equivalent to the inclination in front of them. Therefore, there is no visual feedback with the haptic measure; it is an action that is guided by looking at the hill, but without looking at the hand. Evidence suggests that there is a lack of correspondence between visually guided actions (the palmboard) and phenomenal reports (the disk used for the visual matching task) (Milner & Goodale, 1995). The explicit reports of slant (including the disk measure) allow the observer to decide whether to ascend the hill, whereas the visually guided action ensures that the observer will navigate it successfully. The palmboard can and should be likened to an observer placing the foot on the hill in order to walk up it. Even though they overestimate the slant of the hill with the conscious measures, their perceptual system needs to guide their steps appropriately, so that they do not stumble or fall when stepping onto the hill. The action plan used to guide the step is constructed outside of awareness (for a more detailed discussion of this distinction, see: Witt & Proffitt, 2007).

If psychosocial resources are psychologically equivalent to energetic resources, then an increase in the psychosocial resources should cause hills to appear less steep, as captured by the verbal and visual measures. Psychosocial resources should likewise have no effect on visually guided actions, as indicated by the haptic measure.

Quasi-Experimental Design. Participants in this study were not randomly assigned to “high” vs. “low” social support conditions. Instead, they were passersby who were either alone or who were accompanied by a single acquaintance (i.e., in a “friendship pair”). Participants who were without companions constituted our “low social support” condition, and those with a companion constituted our “high social support” condition.

There are distinct advantages and disadvantages to this quasi-experimental design (see Aronson, Ellsworth, Carlsmith, & Gonzales, 1990, for a discussion). Recruiting naturally-occurring friendship pairs, and doing so outside the more formalized bounds of a laboratory experiment, increased the ecological validity of this study. Participants recruited in this way moved seamlessly from a self-generated social interaction to our study, and thus were unlikely to have cogitated much about the research, the nature of their friendships (if in a friendship pair), or the combination of these factors before engaging in the vision tasks.

However, the lack of random assignment also poses important disadvantages. Chief among them is the inability to unambiguously establish causality. If participants in friendship pairs see hills as less steep, it may be—as we predicted—because of the social resource that social bonds supply. But it may also be due to some "third variable", such as the personality attributes that attract and sustain friendships. However, we decided that the advantages of this design outweighed the liabilities in initiating this line of research.

In sum, we predicted that if the psychosocial resource supplied by social support operates on hill slope perception in the same way as do physical resources, then participants in friendship pairs should perceive hill slopes as less steep than those who were alone. Study 1 tested this prediction.

Method

Participants

Thirty-four students (19 female; mean age: 19.94 years) from the University of Virginia participated. Participants were recruited as they passed by a hill used in previous studies of slant perception (Bhalla & Proffitt, 1999; Proffitt et al., 1995). We did not explicitly restrict participation to same-sex pairs, but only one mixed-sex pair was part of the sample. Eight additional participants completed the study, but their data were excluded because they demonstrated advanced knowledge of hill slants (e.g., they took a perception class).

Stimuli

One hill (26° inclination) on the grounds of the University of Virginia was used.

Apparatus

Participants judged hill slant *verbally*, *visually*, and *haptically*. For the verbal estimates, participants reported hill slant in degrees by writing it down on a piece of paper. As reference, they were told that 0 degrees represented a flat surface and 90 degrees represented a vertical cliff. The visual judgment involved adjusting a disk that represented the cross section of the hill (see Figure 1). The haptic measure required adjusting a tilt board with a palm rest to be parallel to the hill, importantly, without looking at one's hand (see Figure 2).

Weighted backpack. Overestimation of hill slopes is normative—it occurs among most people even when they are not burdened. However, as Bhalla and Proffitt (1999) showed, wearing a heavy backpack causes people to increase their overestimates beyond their normal tendencies to do so. If social support serves as a resource that affects perception, then it should counteract the resource-depletion effects produced by wearing a heavy backpack. For this reason, we had all participants—those in the alone condition and those in friendship pairs—wear a heavy backpack while making their hill slope estimates.

The backpack worn by participants held exercise free weights approximating 20% of the participant's weight. Filling the pack with this amount was based on previous research indicating that participants consider this to be a heavy burden, but it does not cause physical pain or back strain during the study (Bhalla & Proffitt, 1999; Proffitt et al., 2003).

Procedure

Participants were informed that the study concerned people's impressions of the environment. They were escorted individually when in the "alone" condition or in pairs when in the "friends" condition to a flat surface at the base of the hill. Participants indicated their body weight on a form, the experimenter put the appropriate weights into the backpack, and then participants strapped on the backpack. No mention was made of whether participants would have to walk up the hill, because manipulations of walking effort, such as wearing a heavy backpack, influence the perceived layout of the ground even if people do not actually climb or walk it (Bhalla & Proffitt, 1999; Proffitt et al., 1995; Proffitt et al., 2003; Stefanucci, Proffitt, Banton, &

Epstein, 2005).

Each participant was positioned at the base of the hill and completed the three hill slant estimates in a counterbalanced order. Because in the "friend" condition both participants were tested in turn, the participant's friend stood silently about three feet to the left, and faced away from the participant while that person was giving their estimates. Verbal reports were given in writing, and the experimenter took care that during the visual and haptic responses no oral information was given that could provide a cue to the waiting participant. Taking these steps shielded participants from informative or evaluative cues communicated by their friends, and thereby reduced bias.

After making their hill slant estimates, participants removed the backpack and completed follow-up questionnaires wherein they rated their mood (*happy*, *anxious*, *stressed*, *depressed*, *angry* and *sad*) on a scale from 1 (not at all) to 5 (a great degree), their general physical condition (1 = excellent to 6 = poor), their physical condition on that day (1 = excellent to 5 = very unwell), and how often they exercised per week. Participants in the friend condition also indicated how long they had known their friend and how often they and their friend interacted. Lastly, participants in the friend condition rated their feelings toward their friend (1 = not at all friendly to 5 = extremely friendly), and whether they would turn to their friend for help with a problem (1 = not at all to 5 = absolutely).

All these procedures were repeated for the other member of friendship pairs. Lastly, participants were debriefed and dismissed.

Results

Preliminary Analyses

Manipulation Check. It was critical that participants tested in pairs regarded each other as friends, in order to establish the presence of social support. Responses on the post-experimental questionnaire indicated that 71.40% of friend-pairs interacted daily, 21.40% several times per week, and 7.10% several times per month. When rating how friendly they felt toward their companions, 57.10% of "friendship condition" participants selected the top category ("extremely friendly"), with the remaining 42.90% selecting "very friendly." Further, 42.90% indicated they would "absolutely" turn to the other person for help, 28.60% indicated they were "very much" inclined to do so, and 28.60% indicated "somewhat" inclined to do so. Thus, participants in the friend condition were indeed accompanied by a person with whom they enjoyed a strong, positive, and supportive relationship.

Outliers. Boxplots of all three measures were inspected for outliers, and 3 extreme observations (outside of three box lengths of the inter-quartile range) were identified. Data from these participants were excluded.

Primary Analyses

Earlier studies (e.g., Bhalla & Proffitt, 1999) recorded sex differences on the verbal and visual measures of hill slant. Thus, sex and social support condition (friend vs. alone) were used as independent variables in two-way univariate Analyses of Variance (ANOVAs).

Social support. The visual measure confirmed the predicted effect of social support on slant perception. Participants in the friend condition rotated the disc to show a lower angle (M = 44.07, SD = 6.62) than did those in the alone condition (M = 49.24, SD = 7.08), F (1, 27) = 4.36, $p < .05$, $\eta^2 = .14$ (see Figure 3). A similar pattern was found for the verbal measure, with participants in the friend condition estimating the angle of the hill slope (in degrees) to be lower (M = 47.93, SD = 10.57) than did those in the alone condition[1] (M = 55.12, SD = 10.69), F (1, 27) = 3.87, $p < .06$, $\eta^2 = .13$. Main effects of sex emerged, with higher means for women on the verbal measure, F (1, 27) = 6.04, $p < .02$, $\eta^2 = .18$, and, marginally, on the visual measure, F (1, 27) = 3.48, $p < .07$, $\eta^2 = .11$. Support and gender did not interact for the visual measure, F (1, 27) = .10, $p > .75$, or for the verbal measure, F (1, 27) = .89, $p > .36$.

Consistent with accounts of dual visual systems, the friend and alone conditions did not differ on haptic estimates, F (1, 27) = .01, $p < .93$. Also, there was no sex difference for the haptic measure, F (1, 27) = .67, $p > .42$, nor for the interaction of sex and condition, F (1, 27) = .39, $p > .54$.

Duration of Relationship. To test whether relationship strength was underlying the effect of support on slant perception, we correlated the slant estimates with relationship duration (in months) for friends. There was a strong negative association between friendship duration and the visual estimates, r (11) = -.74, $p < .004$, and a similar trend for the verbal estimates, r (11) = -.52, $p < .07$. Thus, the longer friends knew each other, the less steep the hill appeared. This relationship was not evident on the haptic measure, $r = .02$, $p < .94$.

Physical Ability. Because earlier studies had found that fitness influences slant estimates (Bhalla & Proffitt, 1999), we analyzed participants' reported physical ability and fitness. No differences across condition were found regarding general physical condition, physical condition on that day, or frequency of exercising, ps > .22. There were no significant correlations between these indicators of physical fitness and the three slant estimates, all ps > .27.

Mood. To test whether the friend and alone conditions differed in self-reported mood, item ratings (angry, sad, depressed, anxious, stressed, and happy)[2] were combined into a composite score, $\alpha = .84$. An ANOVA with condition as factor did not yield any significant group difference in mood, F (1, 31) = .43, $p > .52$. Further, when correlating the mood composite with the three slant estimates, no significant correlations emerged, all ps > .82. Thus, it is unlikely that the effects on the slant estimates were due to differences in mood.

Friend Estimates as Potential Biases. To statistically test the independence of scores for participants who were friends, we ran the analyses on slant estimates for only the first person in each pair. Analyses involving only the first person tested within the pair resulted in almost identical means for the verbal reports (46.71, compared to 47.93 for all participants), visual reports (42.14 vs. 44.07) and haptic reports (22.00 vs. 24.12). The ANOVA remained statistically significant for the visual measure, F (1, 20) = 5.02, $p < .04$, and, presumably because of a loss of statistical power due to reduced sample sizes, was marginal for the verbal report, F (1, 20) = 2.42, $p < .14$. The result for the haptic measure remained non-significant, in line with our prediction, F (1, 20) = .70, $p < .41$.

No analyses involving testing order (whether a friend gave responses first or second within the pair) resulted in significant differences, for the verbal measure, F (1, 12) = .17, $p <$ .69, the visual measure, F (1, 12) = 1.21, p < .29, or the haptic measure, F (1, 12) = .38, $p < .55$. Thus, order effects did not confound Study 1 results.

Discussion

Participants with a friend, compared to those alone, saw the hill as less steep. Thus, we found that a psychosocial resource, social support, influenced apparent slant in much the same way as do energetic factors. Being with a friend versus being alone only affected measures related to explicit awareness and planning (verbal and visual estimates), and had no effect on the measure of visually guided action (haptic estimate). This pattern is consistent with earlier findings on energetic resources and slant estimates that implicate two different visual systems (Bhalla & Proffitt, 1999; Proffitt et al., 1995).It is important that friendship duration moderated hill slope perception. The longer participants knew their friends, the less steep they estimated the hill to be, on both the verbal and visual measures. Participants in the friend and in the alone conditions did not differ in self-reported mood. In sum, results from Study 1 were probably not confounded by mood.

Although Study 1 supported the predicted effect of psychosocial resources on hill slant perception, it is limited by its quasi-experimental nature because participants were not randomly assigned to the “friend” and “alone” conditions. It is unlikely that different capabilities to perceive hill slants determined whether participants were alone or with friends. However, being with a friend or being alone may reflect individual differences in temperament, efficacy, or other attributes that may themselves have moderated hill slant perception. Study 2 was done, in part, to address this issue.

Study 2

Study 1 provided initial evidence that social support affects the perception of hill slant. However, several questions remained. First, it was not clear whether participants’ friends represented a purely psychological resource (e.g., boosting morale), or instead a potentially instrumental one (e.g., they could physically assist the climb). Also, the friend may have simply produced social facilitation effects, wherein performance on non-complex tasks improves by being done in the presence of others (Bond & Titus, 1983; Zajonc, 1965). If so, then it may have been the mere presence of another person, rather than the supportive relationship to that person, that affected perception in Study1. It should be noted, however, that social facilitation cannot account for the correlation in Study 1 between friendship duration and perceived slant. Finally, the physical presence of a friend may have introduced social desirability confounds, despite our efforts to control for them.

To address these issues, and to replicate the initial finding, we conducted a second study in which participants merely generated thoughts of a significant other, a neutral person, or a person who had betrayed them, and then estimated hill slant. If slant perception is moderated by the supportive quality of relationships, and not simply by the mere presence of another, then hill slopes should appear least extreme in the positive support condition. Further, an imaged friend can only provide moral support but not instrumental support, and cannot surreptitiously convey information about hill slopes or react to hill slope estimates. Finally, Study 2 participants were randomly assigned to support conditions, thereby addressing the "third variable" problem that existed in Study 1.

The "imagined other" procedure has been effectively used in related studies of psychosocial resources. Recalling a positive social contact, relative to a neutral or a negative one, moderated the perception of disturbing infant cries (Harber et al., in press), and of physical pain (Harber & Wenberg, in preparation). It also increased the likelihood of seeking out unfavorable information about oneself (Kumashiro & Sedikides, 2005).

In sum, social support was operationalized in Study 2 by having participants first mentally image a positive, neutral, or negative social contact, and then estimate the slant of a steep hill. Participants in the positive support condition were predicted to estimate the hill as less steep than participants in the neutral support or negative support conditions. As in Study 1, these differences were predicted for the verbal and visual estimates, but not for the haptic estimates.

Method

Participants

Thirty-six students (17 female; mean age: 21.18 years[3]) from the University of Plymouth participated. Four additional participants completed the study, but subsequent questioning revealed they had guessed the study purpose. Further, an error in the procedure occurred for one participant. The data of these five participants were excluded from the analyses.

Stimuli

One hill (29° inclination) on the campus of the University of Plymouth was used.

Imagery instructions

Participants were randomly assigned to one of three imaging tasks, designed to induce positive support, neutral support, or negative support. The imaging tasks, and a preceding relaxation phase, were supplied via a Walkman style tape player. Presenting instructions in this manner reduced confounds arising from direct interactions with the experimenters.

Relaxation phase. Before imaging their assigned support source, all participants completed a brief (2 minute) relaxation exercise, wherein they slowed their breathing and cleared their minds of current worries, concerns, and preoccupations. The purpose of this exercise was to establish a common and reduced level of arousal among all participants, thereby permitting the positive, neutral, and negative support manipulations to more distinctly enhance, leave unchanged, or depress resources, respectively.

Imaging task. Following the relaxation phase, participants received imagery instructions that induced them to think of a specific encounter with either a positive, neutral, or negative support source, to invoke visual images of this person's appearance and actions, and to relive the thoughts and feelings that this person generated. The experimenter was blind regarding which tape was played to the participant, to reduce the possibility of unconsciously influencing responses.

Participants in the *positive support* condition thought of somebody of great personal importance, who made them feel good and who would provide help in a difficult situation. Participants in the *neutral support* condition thought of someone who they saw frequently, but did not know personally (e.g., a store clerk), and who they neither liked nor disliked. Participants in the *negative support* condition thought of someone who was once important to them, but who betrayed them or disappointed them in a time of need.

Procedure

Participants were recruited for a study on "impressions of the environment" as they entered or left a college building near the hill. In individual sessions participants were taken to a private room, where they listened to the imagery instructions in isolation. Next, participants were escorted to a hill that was similar in steepness (29 degrees) to the one employed in Study 1. Participants strapped on a backpack with weights equaling 20% of their own body weight, and then provided the verbal, visual, and haptic slant estimates. A subsequent questionnaire included questions regarding the imaged person and current mood. The experimenter probed for suspicion regarding the study purpose, and participants were debriefed and received a candy bar as compensation.

Results

Preliminary Analyses

Manipulation Checks. It was important to determine whether imaging a positive, neutral, or negative person generated thoughts and feelings consistent with these social targets. Participants' ratings of their imaging experiences and of their imaging targets indicated that this occurred (see Table 1). All items differed significantly across conditions at $p < .001$, with post-hoc comparisons showing that the positive social target was always rated more positively (e.g., more pleasant, more warm, more close, etc.) than the negative social target. Furthermore, the "neutral target" appeared to be just that, generating no greater hostile feelings than the positive target and no greater warmth or closeness than the negative target. The imaging conditions did not differ in ease of creating the images, vividness of the images, or feeling self-conscious during the task (all *p*s > .37). This is important, because it addresses positive affect created by ease of processing or fluency (Winkielman & Cacioppo, 2001), as well as objective self-awareness (Duvall & Wicklund, 1972).

Outliers. Boxplots of all three measures were inspected for outliers; none were identified.

Primary Analyses

Social Support. Separate univariate ANOVAs were conducted for each of the hill slant measures. A main effect of condition was obtained for the verbal measure, F (2, 30) = 3.32, $p <$ .05, $\eta^2 = .18$. Planned comparisons showed that positive support participants verbally reported the hill as less steep (M = 40.00, SD = 15.78) than did the negative support participants (M = 50.00, SD = 8.37), $p < .02$, and marginally less steep than did the neutral support participants (M = 47.58, SD = 7.53), $p < .07$, whereas the negative and neutral conditions did not differ from one another ($p > .60$). A main effect of sex was found, as in Study 1, with women (M = 49.53, SD = 13.65) providing higher verbal estimates than men (M = 42.05, SD = 9.12). Sex and support condition did not interact, F (2, 30) = .52, $p > .60$.

For the visual measure, a main effect of condition was obtained, F (2, 30) = 3.53, $p < .04$, $\eta^2 = .19$. Participants in the positive support condition perceived the hill slope as less steep (M = 34.46, SD = 8.71) than those in the neutral support condition (M = 41.67, SD = 7.54), $p < .03$, and those in the negative support condition (M = 42.27, SD = 6.44), $p < .03$. The visual measure was not related to sex, F (1, 30) = .26, p > .61, and there was no sex by condition interaction, F (2, 30) = .15, $p > .86$. As expected, the social support conditions did not differ on the haptic measure, $p > .73$. Figure 4 displays the effects of support condition on the verbal, visual, and haptic measures.

Unexpectedly, there was an interaction of condition and sex on the haptic measure, F (2, 30) = 4.21, $p < .03$, $\eta^2 = .22$, with the highest estimates for women in the neutral condition (M = 30.20, SD = 8.07) and the lowest estimates for men in the neutral condition (M = 19.14, SD = 6.99). Gender differences on the haptic measure have been found in the past (see Proffitt et al., 1995). However, because this interaction centered on the neutral condition, rather than on the positive or negative social context conditions, it is not regarded as relevant to our central hypothesis, i.e., that social context moderates the perception of hill slant.

Relationship Quality. If visual perception is moderated by supportive relationships, then relationship *quality* should account for this influence. To test this prediction, we correlated the verbal, visual, and haptic measures with feelings towards the imaged target (see Table 2). Consistent with the social support predictions, feeling closeness, warmth, and happiness toward the imaged other were negatively related to the verbal measure of slant perception, and closeness was negatively related to the visual measure of slant perception. Thus, as positive regard for the support source increased, the perceived steepness of the hill decreased. Neutral and negative feelings were unrelated to the visual and verbal measures.

These correlations suggest that the effect of social support on slant estimates may have been mediated by the quality of the relationship. A second set of ANOVAs, in which closeness was entered as a covariate (and was therefore held constant across support conditions) provided further evidence of mediation. When this was done, the previously significant effect of support condition on the verbal estimate became non-significant, F (2, 29) = 0.57, $p = .57$, $\eta^2 = .04$. More tellingly, the effect size of condition on verbal estimates dropped from a moderate .18 to a negligible .04. Controlling for closeness had virtually the same effect on the relation between support condition and visual estimates, F (2, 29) = .94, p = .40, η^2 = .06. Again, both the significance level and the effect size changed from robust to negligible.

In contrast to Study 1, there was no significant negative correlation between the verbal and visual estimates of hill slant, and duration of relationship, ps > .19. However, whereas in Study 1 relationship duration ranged from 1 to 40 months, in Study 2 relationship duration ranged from 3 months to 336 months. This extreme variability of friendship duration indicates that the kinds of people considered in Study 2 were qualitatively different from the friends in Study 1, which were all college friends. Friendships made in college by enrolled college students have brief histories—their duration would only rarely be longer than the 4-5 years of a typical undergraduate enrollment. Within this restricted duration, a connection of a year or more will auger greater intimacy than one of just a few weeks or months. For this reason, duration may serve as a sensitive index of relationship strength for college friendships.

Duration was probably a less sensitive index of relationship strength in Study 2, where participants were instructed to consider *any* important relationship partner, including not only college friends but family members and life-long best friends. For these kinds of long-term connections, duration becomes less meaningful (e.g., “for how long have your known your mother?”) than do indices of quality (e.g., “how close are you to your mother?”).

Mood. The five mood items (anxious, angry, afraid, sad, happy) were combined into a single mood factor, α = .67. A one-way ANOVA showed that the treatment groups did not report different moods, F (2, 28) = 1.66, p < .21, η^2 = .11. In addition, unlike relationship quality, mood was unrelated to either the verbal measure of slant, r (31) = .23, p = .21, or to the visual measure of slant, r (31) = .25, p = .17.

Discussion

Consistent with our predictions, and replicating Study 1 results, participants who thought of a positive social contact estimated the hill to be less steep than participants who had either thought of a neutral contact or a negative contact. In accord with our predictions (and, again, replicating Study 1), differences between experimental conditions were only found on the verbal and visual measures, which are related to explicit awareness, but not on the haptic measure, which is related to the visual control of action.

Factors consistent with our social support hypothesis—namely closeness and warmth associated with the imaged other—mediated perception of hill slant, and in the predicted manner. The more positively participants felt toward their imaged contacts, the less steep the hill appeared to them. Furthermore, this effect of social contact on hill slant perception was neutralized after controlling for closeness.

The results of Study 2 also addressed many potential alternative explanations in Study 1. Discussion of these alternative explanations will be given in the General Discussion section below.

General Discussion

Two studies provided evidence that psychosocial resources moderate the perception of the physical world. These results are strikingly similar to previous research showing that physiological resources moderate spatial perception. Just as physical load, bodily fatigue, and the age and fitness of the perceiver moderate slant perception (Bhalla & Proffitt, 1999; Proffitt et al., 1995), so does the presence and quality of supportive relationships. Social support changed the perception of a challenging physical environment, so that a steep hill appeared less steep in both an in vivo study when a friend was physically present versus not present, and in a study that involved the mental recall of a supportive other versus a neutral or non-supportive other.

Relationship Quality

Of particular interest was evidence that relationship quality mediated the effect of social support on visual perception in both experiments. In Study 1, friendship duration negatively correlated with visual and verbal hill slope estimates—the longer a friend was known, the less steep the hill appeared. These correlations suggest, but do not confirm, mediation. Such confirmation was supplied by Study 2. Here, the feelings of closeness to the imaged other were correlated to both the verbal and visual hill slop estimates. The closer subjects felt toward their imaged social contacts, the less steep the hill appeared to them. More critically, the effect of support condition on both the visual and verbal hill slant estimates became non-significant after closeness was statistically controlled, and the effect size of support condition on both the verbal and visual measures both dropped from moderate to negligible levels. Study 2 therefore satisfied the four criteria for mediation specified by Baron and Kenny (1986):

1. The IV (support condition) was related to the DV (verbal and visual hill slant estimates), and indicated by the initial ANOVA wherein closeness was not covaried.
2. The IV was related to the mediator (relationship closeness), as indicated by the manipulation checks.
3. The mediator was related to the DV, as indicated by the correlations.
4. The effect of the IV on the DV was substantially reduced by controlling the mediator, as indicated by the second ANOVA in which closeness was covaried.

These results are important, because they indicate that the ability of relationships to be supportive (e.g., long-lasting, close, warm) determined the effects of relationships on the visual perception of a potential physical challenge (e.g., ascending a steep hill while wearing a heavy backpack). In other words, the very properties that make relationships a psychosocial resource (duration and closeness) apparently explain why relationships moderate perception.

Alternative Explanations

The presence of others may introduce factors other than social support. Although it was not possible in two studies to address all possible alternative explanations, the present research does account for some of the most prominent candidates.

Social Facilitation

In Study 1, participants in the support condition reported hill slant estimates in the presence of a friend. Social facilitation theory (Zajonc, 1965) might suggest that it was the mere proximity of another person, rather than the support garnered from this person, that affected hill slope perception. However, the imaging task employed in Study 2 addressed this issue. Here, participants mentally invoked either a positive, neutral, or negative social contact. If social facilitation were influencing the results, then participants in all three conditions should have performed equally, since another person was mentally-present for all of them. However, the three groups did not supply equivalent hill slant estimates. Instead, and in accordance with our predictions, participants who invoked a positive other saw the hill as least steep, and those who invoked a negative other saw the hill as most steep. Further, the mediational role played by relationship duration (Study 1) and relationship closeness (Study 2) indicate that it was the supportiveness, rather than the mere presence, of another person that affected hill slant perception. Finally, the dissociation between the verbal and visual measures, where slants differed by support condition, and the haptic measure, where they did not differ, strongly suggests that results were not compromised by social facilitation.

Biasing Cues

Participants in Study 1 who were members of friendship pairs may have responded to intended or unintended cues from their partners during the imaging task, which may have shaped their responses. Multiple safeguards were taken to prevent such bias from occurring, such as having partners face away from each other during trials and having participants report their estimates in ways that their partners could not witness. In addition, as reported in Footnote 3, considering data by the participants in the friend pair who provided estimates first left our results nearly unchanged. However, biasing cues were virtually non-existent in Study 2, wherein social support was induced by the virtual, rather than actual, presence of a social contact, and where the experimenter was blind to each participant's experimental condition. Thus, results are unlikely compromised by the communication of height cues from other experimental participants.

Mood

In both studies the effects of social support remained reliable even after mood was statistically controlled. Furthermore, the direct effects of mood on visual perception were themselves marginal to weak. In neither study did mood vary by experimental condition. One explanation is that our mood measure lacked sufficient sensitivity. This seems unlikely; our measure was straightforward and similar to measures used effectively in other studies. A more likely explanation is that mood and resources are separable phenomena. The dissociation between resources and mood has been reported by Harber, et al. (in press) regarding social support, by Pennebaker (1997) regarding self-disclosure, and by Steele (1988) regarding self-affirmation.

In sum, the most likely alternative explanations for our effects, including social facilitation, biasing cues, and mood, were largely addressed by experimental design and statistical tests.

Lightening the Load: Metaphor or Reality?

We contend that a psychological resource, in this case social support, can affect hill-slant perception in much the same manner as a physical resource. Our procedure for confirming this prediction involved having subjects who were with friends or alone (Study 1) or who thought of a positive, neutral, or negative support source (Study 2) estimate the slope of a steep hill. Before making these judgments, all participants strapped on heavy backpacks in order to provide a maximally challenging context in combination with the steep hill, for which social support might be especially relevant.

Backpacks were not considered central to the underlying effect of social support on hill slant perception. However, an intriguing possibility is that the backpacks were not incidental to the outcome, but instead mediated the effect of social support on slant perception. It may be that social support altered the felt weight of the backpacks, such that participants who were with friends (Study 1) or who thought about a positive support source (Study 2) experienced the backpacks as lighter. The subjective lightening of the backpacks may, in turn, have led to more moderate perceptions of the hill slopes. In support of this explanation, people estimate to-be-lifted objects as weighing less when expecting to receive assistance from others (Doerfeld, Sebanz, & Shiffrar, 2007).

However, there is also support for a direct connection between social support and psycho-physical perception. Harber and Valree (2008) showed that participants with higher self-esteem supplied more moderate height estimates than those with lower self-esteem. Stefanucci, Proffitt, Clore and Parekh (in press) showed that more fearful subjects also supplied more extreme slant estimates than did less fearful participants. In both of these studies the connection between resources or affect states and perception was direct, and was not mediated by changes in physical burdens. Whether psychosocial resources affect visual perception directly, or do so indirectly by changing other physical sensations, is an important question to be addressed in future studies.

Psychosocial Resources and Perception Model

Results from these two studies are consistent with earlier work showing that social support moderates the perception of physical pain (Brown et al., 2003; Harber & Wenberg, in preparation) and the perception of others' distress (Harber et al., in press). Collectively, these studies support the psychosocial resource and perception model (Harber et al., in press), which states that resources moderate the perception of challenges because 1) arousing events are often perceptually exaggerated (Easterbrook, 1959; Rhudy & Meager, 2000; Riskind et al., 1995) and 2) resources, including social support, reduce negative arousal (Karmarck et al., 1990).

An important implication of this model is that psychosocial resources function as a lens through which the social and physical worlds are perceived. The capacity of resources to moderate physical perception may explain, in part, how resources advance coping. If social support, opportunities for emotional disclosure, and differences in hope, optimism, self-worth, and self-efficacy cause people to see challenges in a more moderate way, then people who enjoy these resources will live in a subjectively less demanding and less stressful world. Conversely, those deprived of such resources will live in a world where hills are steeper, distances greater, precipices deeper, and other kinds of physical challenges more daunting and demanding. The stress that these exaggerated perceptions induce, if chronically experienced, could account for the emotional and physical toll experienced by people bereft of psychosocial resources.

Connecting the Social with the Perceptual

This research is part of a recent reemergence of interest in how social factors influence basic perception. Within the past 5-10 years, researchers have shown that cognitive dissonance and emotion influence distance perception (Balcetis & Dunning, 2007) and slant perception (Stefanucci et al., in press), self-esteem (Harber & Valree, 2008) influences height perception, self-resources influence time perception (Vohs & Schmeichel, 2003), social status influences the Ebbinghaus visual illusion (Staple & Koomen, 1997), and fear and anxiety (Rhudy & Meagher, 2000) and self-efficacy (Bandura, O'Leary, Taylor, Gauthier, & Gossard, 1987) influence pain perception. These connections between how people regard themselves and their social worlds, and how they literally perceive the outside world, indicate that social psychological processes saturate human mental activity, and that the "hard" realities of psychophysics can be modified by the "soft" realities of affect, attitudes, associations, and the self.

Conclusion

Past research has shown that perceivers' *physical states* affect their perception of the physical environment. The current studies show that perceivers' *psychosocial states* also influence how the physical environment is perceived. It is too early to speculate on the degree to which these influences share common underlying mechanisms or on what these mechanisms might be. Recent research, however, has begun to look at other bodily influences on visual perception and the results are quite striking. For example, it has been found that manipulating the emotional valence of a cue appearing immediately before a contrast sensitivity grading affects human contrast sensitivity (Phelps, Ling, Carrasco, 2006). Many researchers are expanding the study of human faculties to include influences of embodiment (Chouchourelou, Matsuka, Harber, & Shiffrar, 2006; Proffitt, 2006; Wilson, 2001). The current results suggest that the traditional notion of embodiment should be expanded further to include psychosocial resources drawn from the quality of social relationships.

Footnotes

[1] One might infer from these results that having a friend nearby makes verbal and visual estimates of hill slants more accurate. In absolute terms, this is what we found in our studies. However, based on a functional perspective on perception (e.g., Proffitt, 2006) we distinguish between *absolute accuracy* as captured by the haptic measure and *functional accuracy* as captured by the verbal and visual measures. Absolute accuracy reflects objective reality—in this case the true slope of a steep hill. In contrast, functional accuracy is the correspondence between a person's capacity to engage with a physical environment (e.g., a hill), and the objective features of that environment (e.g., the hill's slant). For people with depleted physical or psychosocial resources, this correspondence is unfavorable. As a result, their minds exaggerate the features of the objective environment with reference to their depleted capacities to negotiate such obstacles. For people with sufficient resources, this exaggeration is lessened—they see challenges as less extreme, in accord with their greater abilities.

Thus, we contend that participants in the high support condition and participants in the low support condition displayed appropriate *functional* accuracy in their perception of the environment: Both groups saw the hill slant relative to their current capacities to negotiate it. In other words, although the two conditions differed in terms of absolute accuracy, both conditions were accurate in a functional sense.

[2] Happiness was reverse-coded to create the composite scale.

[3] Due to a technical error age data were lost for 8 participants, whose ages presumably fell within the age range described for the remaining 24 participants.

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Table 1

Means for Post-Experimental Manipulation Check Items, Study 2 (Standard Deviations in Parentheses).

	Imagery Condition		
	Positive	Neutral	Negative
Imaging Experience			
Pleasantness of images	3.77 (0.93)$_a$	3.00 (1.00)$_a$	1.73 (0.90)$_b$
Disturbing content of images	1.38 (0.77)$_a$	1.17 (0.39)$_a$	3.00 (1.00)$_b$
Feelings Towards Imaged Person			
Closeness	4.15 (0.55)$_a$	1.33 (0.65)$_b$	2.00 (1.48)$_b$
Warmth	4.46 (0.66)$_a$	2.50 (1.00)$_c$	1.45 (0.93)$_b$
Happiness	4.38 (0.65)$_a$	2.17 (1.11)$_b$	1.91 (1.14)$_b$
Neutral regard	1.92 (1.19)$_a$	3.83 (1.19)$_b$	1.82 (0.98)$_a$
Anger	1.08 (0.28)$_a$	1.17 (0.39)$_a$	3.64 (1.03)$_b$
Sadness	1.92 (0.86)$_{ab}$	1.33 (0.65)$_b$	2.82 (1.08)$_a$

Note: Means in the same row with different subscripts differ at $p < .05$, as indicated by Scheffé post-hoc tests.

Table 2

Correlations (r) Controlling for Negative Mood, Between Responses to Imaged Social Target and Measures of Hill Slant Perception (n = 31).

	Verbal Measure *r*	Visual Measure *r*	Haptic Measure *r*
Positive Responses			
Close	-.37 *	-.36 *	.02
Warm	-.33 *	-.28	.13
Happy	-.39*	-.20	.05
Negative Responses			
Angry	.16	.26	-.04
Sad	.25	.16	.23
Neutral Responses			
Neutral	.03	-.10	-.12

Note: * = $p < .05$

Figure 1: Visual Measure. The dark-green section is adjusted by participant to reflect hill slant.

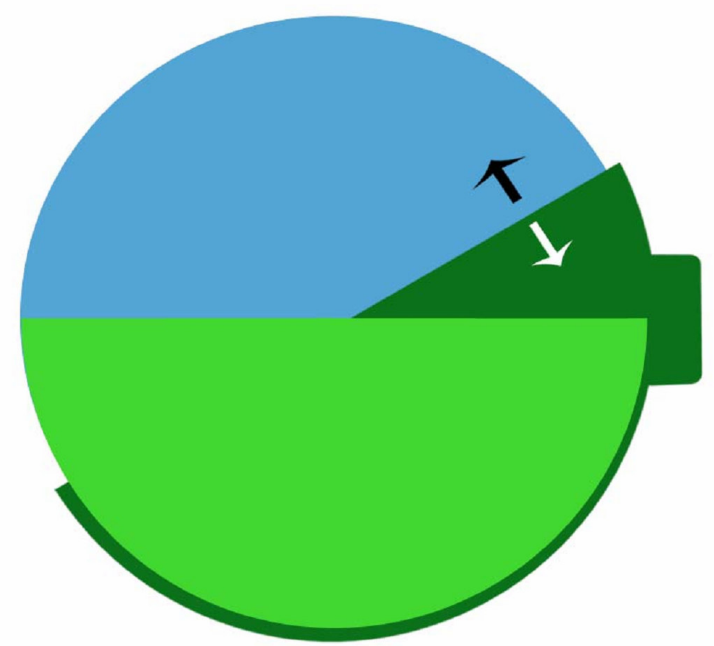


Figure 2: Participant Using Haptic Measure.

Figure 3: Mean slant estimates as a function of being alone or with friend, Study 1. The horizontal line represents the actual slant of the hill (26 degrees).

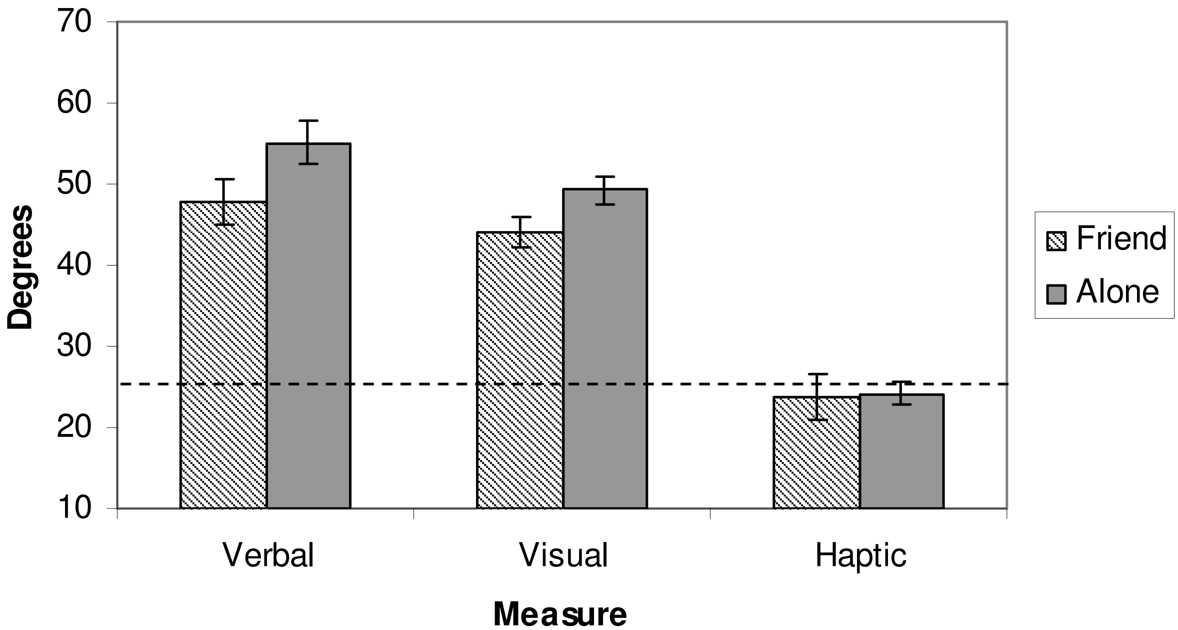
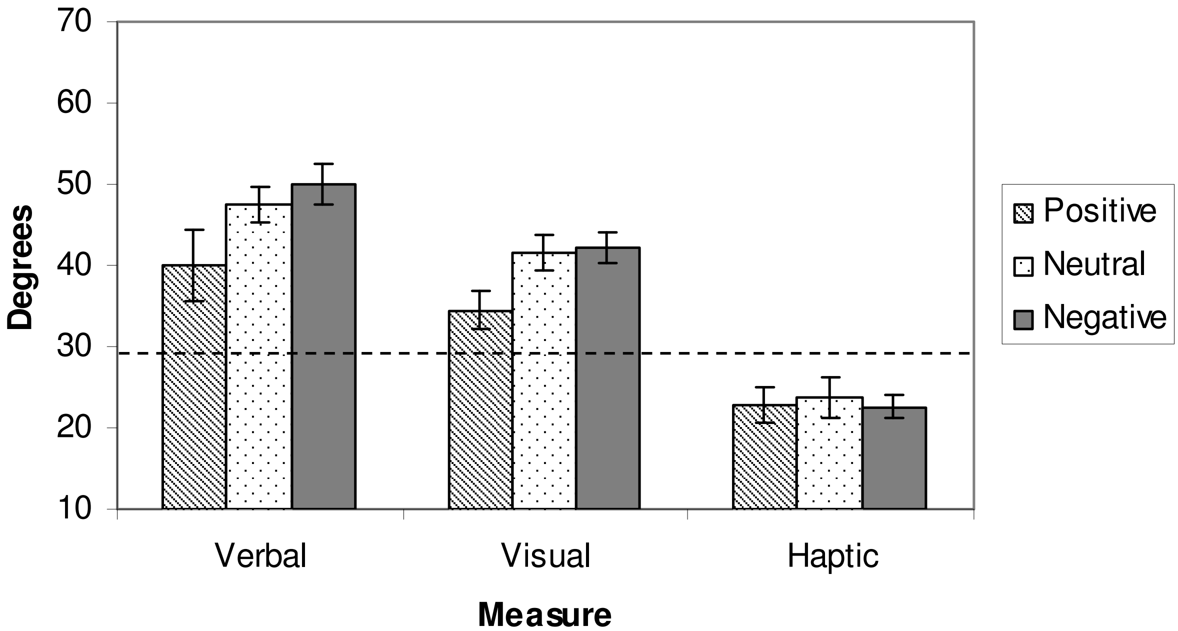


Figure 4: Mean slant estimates as a function of imagery condition, Study 2. The horizontal line represents the actual slant of the hill (29 degrees).



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