Research Article

ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Psychological Science
24(1) 34–40

DOI: 10.1177/0956797612446953
http://pss.sagepub.com
SAGE

Affective Signals of Threat Increase Perceived Proximity

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Abstract

Do stimuli appear to be closer when they are more threatening? We tested people's perceptions of distance to stimuli that they felt were threatening relative to perceptions of stimuli they felt were disgusting or neutral. Two studies demonstrated that stimuli that emitted affective signals of threat (e.g., an aggressive male student) were seen as physically closer than stimuli that emitted affective signals of disgust (e.g., a repulsive male student) or no affective signal. Even after controlling for the direct effects of physiological arousal, object familiarity, and intensity of the negative emotional reaction, we found that threatening stimuli appeared to be physically closer than did disgusting ones (Study 2). These findings highlight the links among biased perception, action regulation, and successful navigation of the environment.

Keywords

perception, affect, emotion, threat, regulation, action, social cognition, distance perception, motivation

Received 1/21/12; Revision accepted 4/8/12

Three rules of mountaineering have been passed down from one climber to the next: It is always farther than it looks, it is always taller than it looks, and it is always harder than it looks. As this inveterate advice suggests, people's perceptions of the surrounding world are rarely veridical, but are instead systematically misrepresentative. Hills appear steep to joggers who are depleted after a run (Proffitt, 2006). Distances appear long to people who suffer from chronic pain (Witt et al., 2009). Locations seem close when they are appealing (Alter & Balcetis, 2011).

Why is perception of the environment biased? Broadly speaking, biased perception may help regulate behaviors, cognitions, and emotions in ways that assist in fulfilling perceivers' needs (Balcetis & Dunning, 2010; Barrett & Bar, 2009; Proffitt, 2006). One basic regulatory need is to act when the situation calls for it. For example, thirsty people need to act to acquire a drink. Lonely people need to act to restore feelings of connectedness. Frightened people need to act to avoid impending danger. When particular action is needed, perceptual representations of the environment may be biased to prompt or encourage that action.

One specific perceptual bias that may cue or promote action relates to actual proximity. When objects of reward are actually located nearby, actions aimed at attaining those rewards increase. Hungry animals run faster and exert more effort as the actual distance to food decreases (Brown, 1948). Actual proximity predicts increases in the amount and intensity of actions that help attain goal-relevant objects (Dollard & Miller, 1950).

We propose that not only actual proximity but also perceived proximity may encourage motivation and action. People are encouraged to act when they perceive that the distance has decreased between themselves and some object, regardless of the actual separation. Thus, the perceptual system is biased in ways known to promote beneficial action. Past work has already shown that people perceive distances to desired objects as shorter than distances to undesired objects. For example, to financially strapped college students, a $25 gift card appeared to be physically closer than did a valueless gift card; likewise, a bottle of water appeared to be physically closer to thirsty people than it did to people whose thirsts' were thoroughly quenched (Balcetis & Dunning, 2010). We theorize that, in these cases, distances to objects appeared shorter because attainment of those objects required action, and perceived proximity may help to motivate goal-relevant behavioral responses to acquire those objects.

The research reported here focuses on another instance in which action best serves the needs of the perceiver. When a threat is present in the environment, people typically need to act quickly, through either fight or flight, and the body responds accordingly. Threats increase sympathetic nervous system activity, which leads to elevated heart rate, blood

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pressure, and cortisol release (Lerner, Gonzalez, Dahl, Hariri, & Taylor, 2005; Prkachin, Williams-Avery, Zwaal, & Mills, 1999). In addition, threats increase activity in subcortical brain regions associated with reflexive-action preparation and defensive behavior (Pichon, de Gelder, & Grezes, 2012). These reactions indicate that the body is prepared for and capable of defensive action. Moreover, threatening objects arouse direct action meant to mitigate the threat (Lazarus, 1966).

The compulsion to act increases when a threat is physically closer (Pichon et al., 2012). As threats move from remote to proximal, cardiac responses accelerate (Fanselow, 1994), and brain activity switches from prefrontal cortical areas to the midbrain regions associated with action preparation (Mobbs et al., 2007). When an unfamiliar object approaches a person quickly, it is appraised as a looming threat, and both adults and infants respond with defensive movements (King, Dykeman, Redgrave, & Dean, 1992). Likewise, many other species, including monkeys, pigeons, turtles, frogs, goldfish, and locusts, respond to the perception of looming threats with defensive behaviors (see Fotowat & Gabbiani, 2011, for a review). Thus, we propose that if readiness to engage in action increases as the proximity of a threat increases, the needs of the perceiver are best served by misperceiving objects as closer when they are more threatening.

In the current research, we tested whether threatening objects in the environment appear to be physically closer than less threatening objects. We propose the *threat-signal hypothesis*: When people feel threatened by an object in the environment, they will misperceive that object to be closer than nonthreatening objects that evoke other equally strong and negative affective responses, such as disgust.

The predictions derived from the threat-signal hypothesis are consistent with findings of other empirical work showing that threat leads to exaggerated perceptual representations. Spider phobics perceived the speed of a spider moving toward them as faster than did nonphobic peers (Riskind, Moore, & Bowlby, 1995). Images of threatening objects appeared physically bigger than neutral or positive images did (van Ulzen, Semin, Oudejans, & Beek, 2008). The threat of falling caused people to overestimate how far it was to the ground when they stood on a balcony ledge (Stefanucci & Proffitt, 2009).

In addition, the threat-signal hypothesis suggests that perception is intrinsically linked to the regulation of action—an assumption reminiscent of the New Look perspective, developed in the mid-20th century (Bruner, 1957). This classic perspective suggests that to facilitate appropriate responses, people maintain a readiness to perceive objects in the environment that are capable of satisfying needs. Unfortunately, this classic perspective suffered from methodological and theoretical shortcomings that rendered its empirical findings tenuous (Erdelyi, 1974). For example, classic research demonstrating the effect of subjective construal—as defined through emotional valence, individual value, and personal meaning—on perception confounded these psychological constructs with frequency of exposure (Adkins, 1956). Given that target familiarity predicts representations of psychological closeness (Stephan, Liberman, & Trope, 2010), the effect of subjective construal in perception was never clearly established. Further, classic research could not isolate the effects of visual perception from memory processes (Carter & Schooler, 1949). Thus, in the present research, we improved on the methodological shortcomings of existing research in key ways by controlling for the confounding effects of frequency of exposure and memory, increasing theoretical rigor, and testing a more sophisticated model of the function of perceptual bias.

The Present Studies

In two studies, we tested the threat-signal hypothesis by asking participants to estimate the distance to a threatening, disgusting, or neutral object. We measured (Study 1) and manipulated (Study 2) affective responses to the object. In both studies, we predicted that viewing threatening objects would increase the perceived proximity of those objects compared with viewing objects that evoked another strong negative affective response: disgust.

By making comparisons between threatening and disgusting objects, we were able to evaluate the specific claim that threat increases perceived proximity because of the need to act when a threat is present. If the need to act leads to perceived proximity, disgusting objects should not be perceived as close. Although fear and disgust are both negative and intense emotions, they differ in the amount of immediate action they call for. Both fear and disgust may be associated with avoidance tendencies, but fear typically necessitates active mobilization to withdraw from or dispel potential threats, whereas disgust does not. Compared with fear, disgust is much less strongly tied to anticipated effort and exertion (Smith & Ellsworth, 1985). Whereas feelings of fear increase activity in the sympathetic nervous system, prompting the body to mobilize for action, disgust activates parasympathetic responses, actually decreasing heart rate, blood pressure, and respiration (Woody & Teachman, 2000) and thereby suppressing action responses. Compared with fear, disgust generally is associated with a more static avoidance of objects and decreased action readiness (Stanley & Knight, 2004).

In Study 2, we also tested the threat-signal hypothesis while controlling participants' arousal levels. Arousal itself can influence how people visually process a scene by shifting attention to different aspects of the environment or highlighting peripheral cues (Shahbazi, Taher, & Hadadi, 2011), which may affect distance perception. Therefore, we assessed and statistically controlled for physiological arousal by measuring heart rate. Following the threat-signal hypothesis, we predicted that threatening objects would appear closer than disgusting or neutral objects would, even when controlling for familiarity, physiological arousal, and intensity of experienced negativity.

Study 1

In Study 1, participants saw a live tarantula, reported the degree to which they felt threatened and disgusted, and estimated the distance to the tarantula. Feelings of fear and disgust often co-occur (Woody & Teachman, 2000), but the two emotions are conceptually independent and can have different effects. For instance, the propensity to feel fear but not disgust predicts increased avoidance tendencies toward spiders (Vernon & Berenbaum, 2008). We predicted that the tarantula would be seen as physically closer to the extent that it was threatening but not to the extent that it was disgusting.

Method

In exchange for extra credit, 101 undergraduates (51% female, 49% male) participated in a study ostensibly measuring their thoughts about "island life." Participants were brought into a long room. Before participants arrived, we placed a live tarantula in a tray on a table. After entering the room, participants stood 156 in. away from the tarantula.[1] Participants then completed a survey, on which they estimated how many inches separated them from the tarantula (the survey contained a 1-in. line as a reference). While they looked at the tarantula on the table, participants reported, at that moment, how "threatened or frightened" and how "disgusted" they felt, using a Likert scale ranging from 1 (*not at all*) to 7 (*very much*).

Results and discussion

We tested whether feeling threatened and disgusted by a tarantula influenced perceptions of its distance from the perceiver. Zero-order correlations indicated that participants saw the tarantula as closer as they experienced more threat, $r(99) = -.21$, $p < .04$ (Fig. 1a). Ratings of disgust, however, bore no relationship to distance estimates, $r(99) = -.06$, n.s. (Fig. 1b). We categorized participants according to the feelings they experienced: more threat than disgust, more disgust than threat, or equal levels of threat and disgust. We tested a specific contrast predicting distance estimates (threat as primary feeling = −1, equal feelings = 0, disgust as primary feeling = +1). This contrast was significant, $t(97) = 2.33$, $p = .02$. Participants who felt more threatened estimated that the tarantula was closer ($M = 58.9$ in., $SD = 10.5$) than did participants who felt more disgusted ($M = 86.3$ in., $SD = 5.2$); estimates from participants who felt equal levels of threat and disgust fell in between ($M = 67.8$ in., $SD = 5.2$).

To test our primary prediction, though, we tested the unique relationship that each emotion had to distance estimation. To do this, we ran a regression analysis that predicted participants' distance estimates from their feelings of threat and disgust, and their interaction (after centering reported feelings to control for collinearity). The overall model was significant, $R^2 = .09$, $F(3, 99) = 3.04$, $p = .04$. There was a significant main effect of threat, $b = -11.38$, $t(99) = -2.92$, $p = .004$. Participants who experienced more threat saw the tarantula as closer than

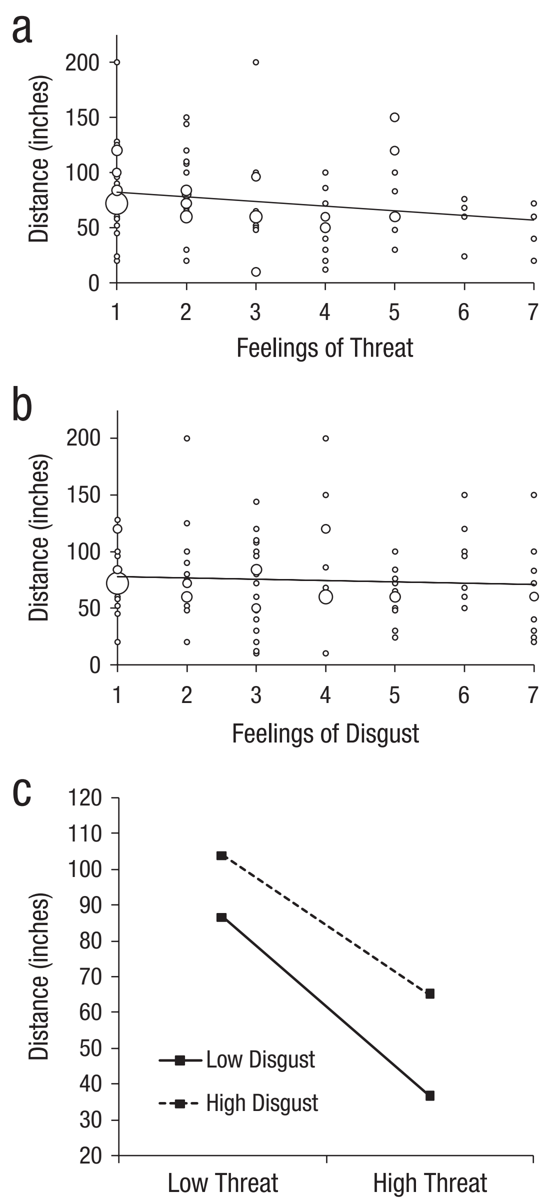

Fig. 1. Results of Study 1. The scatter plots in (a) and (b) depict participants' estimates of the distance of a tarantula as a function of their ratings of how threatened and how disgusted they felt by it, respectively. Larger circles indicate more participants, and lines depict the slope of the zero-order correlations between the reported feeling and distance estimate. The graph in (c) shows participants' estimates of the distance of a tarantula as predicted by whether their levels of threat and disgust were high (1 *SD* above the mean) or low (1 *SD* below the mean).

participants who experienced less threat. There was also a significant main effect of disgust, $b = 6.56$, $t(99) = 2.06$, $p = .04$. However, participants who experienced greater disgust saw the tarantula as farther away than did participants who experienced less disgust. The interaction between threat and disgust was not significant, $b = 0.82$, $t(99) = 0.75$, $p = .46$. Figure 1c depicts the model's predicted means of distance estimates at high (1 *SD* above the mean) and low (1 *SD* below the mean) levels for both emotions (following procedures outlined by Aiken & West, 1991).

Study 1 provided preliminary evidence that an object is perceived as closer to the extent that participants feel threatened by it. This is not the result of increased negativity generally, because disgust led to perceptual representations of the object as farther away—a bias related to inaction—when we statistically isolated the effect of disgust. Thus, Study 1 provided initial support for the threat-signal hypothesis: The affective signal of threat leads to perceived proximity to an object producing the threat.

Study 2

In Study 1, individual differences in feeling threatened and disgusted biased perceptions of distance. In Study 2, we manipulated rather than measured affective signals to create a unique experience of threat and disgust. We chose a stimulus object—namely, another person—with whom participants had no prior associations, to rule out factors of familiarity, frequency of exposure, and whether memory for affective reactions or interactions with the stimulus contributed to perceptual representations of distance. In addition, we included an affectively neutral condition to provide a baseline against which we could test the specific effect of threat on distance perceptions.

In Study 2, we also controlled for the direct, physiological effect of arousal on distance perception. To be sure, physiological arousal does exert a direct influence on some aspects of vision. For example, increased heart rate improves the speed and accuracy of the detection of threats (Shields, Larson, Swartz, & Smith, 2011). Because the mere presence of another person, which constituted our target object, has been shown to increase heart rate (Vrana & Rollock, 1998), we measured and statistically controlled for heart rate. Although heart rate is a reliable measure of arousal, it is not a sensitive measure of readiness or physiological preparation for action (Gendolla, Wright, & Richter, 2012) because it is determined by both sympathetic and parasympathetic nervous system activity (Brownley, Hurwitz, & Schneiderman, 2000). Thus, by measuring heart rate, we controlled for the effects of physiological arousal on distance perception without eliminating effects driven by action readiness.

In Study 2, female undergraduate participants saw a male experimental confederate with whom they had never previously interacted. Our sample included only female participants because there is considerable evidence that women are more sensitive to affective signals, particularly those of threat, than are men. For instance, compared with men, women display greater neural responses to fear (Butler et al., 2005) and perform with greater accuracy on tasks involving recognition of emotional displays of threat and disgust (Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005). We manipulated whether the male confederate was presented as threatening, disgusting, or neutral. We predicted that after the confederate acted in a threatening manner, he would be perceived as physically closer than after he acted in a disgusting or neutral manner, even after we adjusted for the direct effect of physiological arousal.

Method

In exchange for extra credit, 48 female undergraduates participated in a study on impressions. They met a male student (actually a confederate) with whom they would interact; all participants met the same male confederate. The experimenter then chose, ostensibly at random, the confederate rather than the participant to make a short video describing himself. The videos were actually prerecorded.

Each participant was randomly assigned to watch one of three videos of the confederate. Participants in the threat condition (n = 19) watched a video in which the confederate said that his favorite hobby was hunting, talked about how much he loves holding guns, and mentioned how he has no way to get out his aggression in the city so he often feels as if he could explode. Participants in the disgust condition (n = 14) watched a video in which the same confederate talked about a recent summer when he worked at a fast food restaurant and did things to customers' orders, such as urinate in their sodas and spit in their food. Finally, participants in the neutral condition (n = 15) watched a video in which the same confederate talked about the classes he was taking next semester in a neutral manner.

The experimenter brought participants back into the room with the confederate, who sat 132 in. away from them. To measure physiological arousal, we recorded each participant's heart rate immediately before the interaction. Participants indicated on a survey both how "threatening" and how "disgusting" they felt the confederate was at that moment, using a 7-point Likert scale ranging from 1 (*not at all*) to 7 (*very much*).

Participants also estimated and recorded how many inches separated them from the confederate (the survey contained a 1-in. line as a reference). Participants were probed for suspicion about the manipulation and debriefed.

Results and discussion

Manipulation check. To assess participants' affective experiences in the three conditions, we ran a 3 (condition: threat, disgust, neutral) × 2 (experienced affect: threat, disgust) repeated measures analysis of variance with the second factor as a within-subjects variable. As expected, there was a significant interaction between condition and type of affect experienced, $F(2, 45) = 39.94$, $p < .001$, $\eta_p^2 = .64$ (see Table 1). Compared with participants in the disgust and neutral conditions, participants in the threat condition reported that the confederate seemed more threatening. Compared with participants in the threat and neutral conditions, participants in the disgust condition reported that the confederate seemed more disgusting. In addition, the strength of participants' reported feelings of the targeted affective experience did not differ between the

Table 1. Results of Study 2: Mean Affect Ratings and Distance Estimates

Measure	Confederate condition		
	Threat	Disgust	Neutral
Threat rating	5.3_a (1.8)	2.8_b (1.1)	2.1_b (1.4)
Disgust rating	2.8_a (1.6)	5.1_b (1.7)	1.7_c (1.5)
Distance estimate (in.)	55.0_a (5.5)	78.4_b (6.2)	73.9_b (6.3)

Note: Within a row, values with different subscripts are significantly different ($p < .05$). Standard deviations appear in parentheses.

threat and disgust conditions. Feelings of threat experienced by participants in the threat condition did not differ from feelings of disgust experienced by participants in the disgust condition, $t(45) = -0.36$, $p = .72$, $d = 0.15$. Thus, the intensity of intended affective signals between the two conditions was equivalent.

Perceived distance. Perceptions of distance depended on how the confederate behaved, $F(2, 45) = 3.13$, $p = .05$, $\eta_p^2 = .12$. This effect held when adjusting for heart rate, $F(2, 43) = 4.59$, $p = .02$, $\eta_p^2 = .15$.[2] As reported in Table 1, the confederate appeared closer in the threat condition than he did in the disgust condition, $t(43) = 2.85$, $p = .007$, $d = 0.87$, and in the neutral condition, $t(43) = 2.35$, $p = .02$, $d = 0.72$. Estimates of distance to the confederate in the disgust and neutral conditions did not differ, $t(43) = 0.52$, $p = .61$, $d = 0.16$. Experimentally induced affective signals of threat (but not disgust) led to perceived proximity, irrespective of physiological arousal.

General Discussion

In the two studies reported here, we tested the threat-signal hypothesis, which suggests that distances to threatening objects appear shorter than distances to nonthreatening objects because, from a functional perspective, perceived proximity is believed to encourage action. Individual differences in affective experiences of threat predicted differences in perceived proximity to the source of the threat, but affective experiences of disgust did not (Study 1). Likewise, making an unfamiliar person with whom participants had no prior associations seem threatening prompted participants to see that person as closer than an unfamiliar person who seemed disgusting or neutral (Study 2). The effect of threat on perceptual bias occurred even when we adjusted for the direct effect of physiological arousal on distance estimates (Study 2). Further, perceived proximity was not the result of intensity of felt negative emotions; intensity of threat and disgust were equated, yet only the threatening person appeared closer (Study 2).

Our results also provide support for the idea that perceptual biases are the result of threat and its associated emotions, such as fear, and not the result of negative emotions in general. We provided discriminant tests by including conditions in which stimuli evoked disgust. Disgust is a strong negative emotion, but does not require an immediate behavioral response. If perceived proximity promotes action, disgusting stimuli should not be perceived as physically closer than threatening stimuli. Indeed, a disgusting object appeared to be farther away than a threatening object in Study 1. Disgust had no impact relative to a neutral condition in Study 2.

Affective experience and perception

Though we found considerable support for the threat-signal hypothesis, the relationship between affect and perception may be more complex than our results capture. Other research on emotions and perception of the environment suggests that active affective states may carry over to influence perception of even unrelated objects. For example, participants who recalled a sad event subsequently perceived a hill to be steeper than did participants who recalled a happy event (Riener, Stefanucci, Proffitt, & Clore, 2011). The hill itself did not produce an affective state in participants and yet perceptions of it were biased in accord with perceivers' emotional state. Experiencing an emotional state may have effects on perception independent of the functional, regulatory biases predicted by the threat-signal hypothesis. Although affective experiences may generally influence perception of objects in a manner unrelated to the affect, the threat-signal hypothesis predicts a specific perceptual bias when the affect is tagged to specific objects in the environment. Future research could systematically test the independent and interactive effects of affective signals and ambient affective states on distance perception that occur as people regulate incidentally experienced emotions and the action tendencies associated with functional navigation of environments.

In Study 2, we controlled for a direct effect of physiological arousal and still showed that threatening objects appeared closer than did disgusting ones. If the effect of threat on distance perception was not exclusively due to changes in arousal, why then did threatening objects appear closer? One possible mechanism is attention. It may be that threat has disproportionate effects on attention, which influences perceptions of distance. Vigilance for threat is crucial to organisms' survival. Threatening objects capture and narrow the scope of visual attention (Chajut & Algom, 2003). Narrowed focus of attention may influence distance perception. Some evidence suggests that distances appear shorter when attention is narrowly focused on the target object. For example, in one study, hungry participants who focused on chocolate chip cookies estimated that they were 15% closer than did participants with a more expansive focus of attention (Balcetis, 2006). Thus, threatening objects may appear closer because perceivers' attention more narrowly focuses on them compared with disgusting or neutral objects. Additional research is needed to explore whether the effects present in the current study are attributable to differences in focus of visual attention.

Perceptual biases and action

The current findings add to a growing body of research and theory suggesting ways in which perception relates to and promotes functional action (see Witt, 2011). For instance, to discourage action, slopes and distances appear greater when energy is in short rather than great supply (Proffitt, 2006). Additionally, perception of objects' size is exaggerated so that they become easier to detect in the environment and more likely to be acted on when those objects can satisfy goals (Veltkamp, Aarts, & Custers, 2008). Distances to objects are underestimated to encourage action that assists in acquiring them when they are needed for a goal (Balcetis & Dunning, 2010). Converging evidence suggests a link between perceptual biases and action regulation.

Perceptions of the environment and the action responses within it are not independent, but instead they are dynamically interwoven psychological processes. An important next step for advancing the perception-action link is to provide further and direct evidence about whether perception predicts action tendencies. That is, do specific patterns of perceptual representations predict specific behavioral changes? Are perceivers actually quicker to act when threatening objects appear to be physically closer? These and other questions must be addressed before a clear picture emerges of how affective states inform perception and thereby guide action.

Acknowledgments

We thank Hamish Gunn, Sam Zhang, and Sarah Rosen for assistance with conducting the experiments. We also appreciate comments provided by Jennifer Beer, Christopher Peacocke, Jesse Prinz, and Yaacov Trope on earlier versions of this manuscript.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Notes

1. The tarantula was alive and able to move around freely in this tray; therefore, the direction in which the tarantula initially faced was randomly distributed across participants.

2. The effect of condition on distance perception was greater when heart rate was included in the model. Heart rate did not meet the criteria for a suppressor effect. That is, heart rate was significantly correlated with the dependent variable of distance perception, $r(48) = -.34$, $p = .02$.

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