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Review article

Translating dynamic defense patterns from rodents to people

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ABSTRACT

Specific defensive behaviors of rodents are shaped by features of the eliciting threat stimuli and situation. Threat scenarios confirmed these relationships in people, with results substantially replicated in 4 additional scenario studies. Subsequent human studies involve computer games measuring fear as flight from threat stimuli and anxiety as alternation between two threats. Stabilometric studies have shown reduction in sway (freezing) to inescapable (e.g. with gun pointed at subject) threatening photographs; but enhanced lateral sway (flight attempts) to escapable threats; (gun pointed away from subject). Relationships between threat ambiguity, risk assessment, and anxiety have been validated by identification of videos of facial expressions to ambiguous threats, as anxiety; and systematic biases toward threat stimuli by anxious individuals. Enhanced rumination, interpretable as unsuccessful risk assessment, is a dynamic component of both anxiety and depression, particularly in women. While there is less experimental work on defensive threat/attack, a transdiagnostic "Fear of Harm" phenotype of aggression associated with fear suggests that this is a component of pathological as well as normal human defensive behavior.

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1. Introduction

Analyses of defensive behaviors as evolutionarily adaptive responses to threat suggest that the success of any individual defense depends on the fit between that response, the threat that elicits it, and the situation or context in which it occurs. This notion was a driving force for a series of experiments done on domesticated rodents and some of their wild congeners, over many years in our laboratory (e.g. Blanchard and Blanchard, 1969; Blanchard et al., 2003). These studies involved both seminatural habitats for groups of rats or mice, such as the Visible Burrow System (e.g. Blanchard and Blanchard, 1989); and groupings of tasks such as the Mouse Defense Test Battery (MDTB) designed to systematically vary threat and context characteristics important in the selection of individual defensive behaviors (e.g. Griebel et al., 1996; Blanchard et al., 2003). For example, the MDTB, run in a long oval runway permitting endless escape, could be quickly modified to trap the subject,

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providing a differentiation between escapable and nonescapable situations. Such studies provided a set of hypotheses for predicting which defensive behaviors would be likely to appear in an array of situations incorporating different stimulus and contextual features (Blanchard, R.J. et al., 1990). These relationships, and the resulting hypotheses, are reviewed in, e.g. (Blanchard et al., 2001, 2003). Very briefly, they suggest that the dominant defensive response to discrete and clearly threatening stimuli depends on the subject's knowledge of the situation: If there is a way out, flight prevails; if not, freezing. An additional factor is the distance between threat and subject, with defensive threat/attack becoming more common as this distance decreases. When the threat is ambiguous or unlocalized, risk assessment (RA) is the dominant response. In highly social species, and especially when conspecifics are nearby, species-typical vocalizations may serve several different functions, from warning the conspecifics to soliciting help.

2. The scenario studies

2.1. The initial study

In an effort to determine if such rules were also valid for human defensive behaviors Blanchard et al. (2001) created 12 scenarios incorporating core features of threat stimulus and context, including magnitude of threat; ambiguity of threat; distance between threat and subject; escapability of the situation; presence of a hiding place. Here are examples of scenarios from Blanchard et al. (2001) presenting low or high levels of threat ambiguity.

(elevator) You are alone in an elevator late at night. As it stops and the doors open, a menacing stranger rushes in to attack you, blocking the door. (low ambiguity).

(*park*) You are outside in a park area at night when you see a menacing stranger with a knife about 30 ft away directly approaching you. It is obvious the person is planning to attack you. (low ambiguity)

*(noise) You are sleeping in bed during the night, but suddenly wake up thinking you have heard a suspicious noise. It is dark and you are alone. (*high ambiguity).

(*acquaintance*) You and someone you do not really know that well are standing around and talking in an empty parking lot. The acquaintance begins to shove and push you. You are unsure whether s/he (same sex as you,) is serious or just kidding around. (high ambiguity).

For each scenario these factors were rated by panels of graduate students in psychology. The scenarios were then read by 160 students in a community college in Honolulu who made (open-ended) choices of defensive behaviors in each such situation, enabling correlations to be calculated between mean ratings for features of threat stimuli/situations and defense outcomes, across scenarios

With only 12 scenarios, significance requirements for correlations between the rated values of specific features such as threat stimulus ambiguity, and responses, were high; A correlation of 0.58 in the predicted direction for $p < 0.05$. This level of significance was obtained for 8 specific hypotheses based on the animal literature, providing strong support for a view that factors important in determining the 'choice' of specific defensive behaviors in rodents play much the same role in human responses to conspecific threat scenarios. Although all of the significant correlations (necessarily) involved substantial relationships between stimulus/situational features or factors and particular behaviors, some of these were particularly robust, such as $r = +0.86$ (women) and +0.89 (men) between threat ambiguity and risk assessment (RA) behaviors, or between situational inescapabilty and attack (Blanchard et al., 2001). In line with findings from drug studies using animal models, and analyses of the functions of RA to investigate potential threat, we hypothesized that RA was the core defensive behavior involved in anxiety, as opposed to fear, the response to discrete, clearly threatening stimuli (Blanchard, D.C. et al., 1990; Blanchard, R.J. et al., 1990).

2.2. The replications

Perkins and Corr (2006), in the UK, used the same scenarios, additionally evaluating several fear, anxiety, and personality scales. Replication of the original scenario study was treated as a 'preliminary' goal: The focal emphasis of the study was on the relationship of these findings to personality measures, and particularly to a "defensive direction" view by McNaughton and Corr (2004) that fear reflects orientation away from threat, while anxiety reflects orientation towards threat. However, the findings of the original Blanchard et al. (2001) study were confirmed in substantial detail (Perkins and Corr, 2006; Table 3), as was, based on a specific reading of the defensive behaviors involved, the core Gray and McNaughton (2004) hypothesis of 'defensive direction'.

Central to this 'defensive direction' interpretation was the coding of most categories of defense: attack, yell/scream; look for a weapon; RA; threaten to scream; threaten to attack; and beg, plead, negotiate; as representing defensive directions toward threat, while run and hide are coded as defensive directions away from threat, with freezing as neutral. The prediction that anxiety (Spielberg Trait Anxiety) scores were associated with an orientation toward threat was confirmed, with significant, albeit modest, relationships in a multiple regression analysis (Pearson et al., 2006).

Perkins et al. (2010) involved extensions, in addition to replicating the 'defensive distance' findings of Perkins and Corr, 2006. Findings for this replication were mixed, in that while fear scores were significantly and positively associated with the tendency to orient away from threat, trait anxiety was not significantly associated with the choice of behaviors interpreted as directed toward threat in response to the scenarios. Notably, and relevant to the anxiety findings of both scenario studies (Perkins and Corr, 2006; Perkins et al., 2010), the "defensive direction" concept, in which most defenses are seen as directed toward threat and thus associated with anxiety, is only partially congruent with a view that RA is the specific defense involved in anxiety. In addition, although RA is clearly associated with approach, its core function relevant to anxiety is not approach per se, but investigation of the threat stimulus and the situation in which it is encountered: This difference suggests that inclusion –in addition to RA– of a host of additional defenses (such as "scream") defined in that context as "directed toward" threat, may be responsible for the relatively modest relationship between "directed toward threat" behaviors and trait anxiety in the two Perkins studies: Scream, as well as other behaviors in this group, has no apparent RA function.

In Perkins et al. (2010) 'factor ratings' of stimulus and situational characteristics were done by individual subjects just prior to their selection of behaviors in response to each scenario, enabling examination of the effects of these subject-generated factor evaluations on the choice of individual behaviors. Results indicated that the perceived intensity of threat was positively and significantly correlated with both 'defensive direction' and 'defensive intensity' as were the latter two with each other. In terms of the McNaughton and Corr (2004) formulations, findings suggesting that withdrawal/escape reactions ("directed away from") will be stronger than approach ("directed toward") when threat is close or intense were confirmed. This prediction is consonant with a range of findings from animal studies (Blanchard et al., 2004).

Shuhama et al. (2008) translated the scenarios into Portuguese, and solicited defense choices for each, from 248 Brazilian medical students. Again, these choices closely matched those of undergraduates in Hawaii. . .and indeed of rats and mice under similar