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Emotional Mental Imagery as Simulation of Reality: Fear and Beyond—A Tribute to Peter Lang

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This article pays tribute to the seminal paper by Peter J. Lang (1977; *this journal*), "Imagery in Therapy: Information Processing Analysis of Fear." We review research and clinical practice developments in the past five decades with reference to key insights from Lang's theory and experimental work on emotional mental imagery. First, we summarize and recontextualize Lang's bio-informational theory of emotional mental imagery (1977, 1979) within contemporary theoretical developments on the function of mental imagery. Second, Lang's proposal that mental imagery can evoke emotional responses is evaluated by reviewing empirical evidence that mental imagery has a powerful impact on negative as well as positive emotions at neurophysiological and subjective levels. Third, we review contemporary cognitive and behavioral therapeutic practices that use mental imagery, and consider points of extension and departure from Lang's original investigation of mental imagery in fear-extinction behavior change. Fourth, Lang's experimental work on emotional imagery is revisited in light of contemporary research on emotional psychopathology-linked individual differences in mental imagery. Finally, key insights from Lang's experiments on training emotional response during imagery are discussed in relation to how specific techniques may be harnessed to enhance adaptive emotional mental imagery training in future research.

Keywords: mental imagery; visual imagery; emotion; cognitive therapy; behavior therapy

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SCIENTIFIC INTEREST IN MENTAL IMAGERY dates back to the 19th century (Galton, 1880), making imagery one of the most enduring topics in psychological science. Despite such extended interest in the phenomenon of imagery, Peter Lang was one of the first scientists to formulate a testable theory of emotion-inducing

mental imagery. Lang's bio-informational theory (1977, 1979) of emotional imagery was originally developed to explain the role of mental imagery in facilitating behavioral fear extinction in imaginal exposure therapy. Lang's (1977, 1979) theory opened an experimental window onto "the mind's emotional eye," and has spurred research and influenced clinical practice in the ensuing decades. In reviewing theoretical, empirical, and clinical developments related to emotional mental imagery, we aim to highlight the contemporary relevance of Lang's theory, while drawing attention to key insights that we believe are capable of exerting a beneficial impact on future research and clinical practice in years to come.

LANG'S BIO-INFORMATIONAL THEORY OF EMOTIONAL IMAGERY

Mental imagery refers to perceptual experience in the absence of sensory input, commonly described as seeing with the "mind's eye," hearing with the "mind's ear," and so on (Kosslyn, Ganis, & Thompson, 2001). In this paper we consider mental imagery both as an emotion-evoking stimulus that can be manipulated (e.g., during therapeutic techniques such as imaginal exposure; Foa, Hembree, & Rothbaum, 2007), and as a symptom of psychopathology (e.g., distressing intrusive memories/flashbacks in posttraumatic stress disorder; cf. Holmes & Mathews, 2010).

In his bio-informational theory of emotional imagery, Lang (1977, 1979) postulated that a mental imagery representation of an emotionally charged stimulus (e.g., a spider) activates an associative network of stored information that overlaps with that activated during actual experience of the stimulus in reality (e.g., encountering a live spider).

This associative network of information is said to consist of perceptual information about the stimulus (color, shape, size, texture of spider), semantic information about what it means (insect, danger, bite), somatovisceral response information about what it feels like to encounter the stimulus (fear, racing heart), and preparatory motor responses evoked by the encounter (e.g., muscles tensing to flee from the spider). According to this theory, mental imagery differs from verbal thought in that only mental imagery has the capacity to activate physiological and behavioral response systems (Lang, 1987). Research pertaining to this assertion will be discussed in Section III.

Lang's (1977, 1979) associative-network information processing definition of mental imagery was influenced by Pylyshyn's (1973) propositional theory of mental imagery, which construed mental imagery as conceptual representations describing reality, rather than as pictorial representations depicting reality. Historically, the debate concerning whether mental imagery involves conceptual representations (Pylyshyn, 1973) or pictorial representations (Kosslyn, 1981) has been the subject of heated debate. Neuroimaging and psychophysics evidence gathered in the past 50 years has largely resolved the debate in favor of the latter view (see Pearson, Naselaris, Holmes, & Kosslyn, 2015, for a review). Although this appears to refute the grounds of Lang's bio-informational theory, closer inspection reveals that the validity of this theory stands irrespective of whether mental imagery is conceptual or pictorial in nature.

As Lang (1987) explicated, the bio-informational theory was developed not as a theory on the nature of mental imagery, but as a functional theory concerning the impact of mental imagery on emotional processing. Due to the overlap in perceptual information between imagined and real stimuli, Lang (1977, 1979) proposed that imagined interaction with a stimulus can evoke corresponding emotional responses associated with real interaction with that stimulus. As such, imagined interaction with stimuli can function as an "as-if real" template for rehearsing and modifying emotional and behavioral responses to the same stimuli in real life. Lang (1977, 1979) proposed that this function of mental imagery could be harnessed in clinical treatment to facilitate fear-extinction learning and habituation via the rehearsal and learning of new adaptive responses during imaginal exposure therapy.

Indeed, numerous studies using a range of associative learning paradigms have shown that mental imagery can produce conditioned responses in the same way as real stimuli (cf. Dadds, Bovbjerg, Redd, & Cutmore, 1997; Lewis, O'Reilly, Khuu, & Pearson, 2013). Crucially, Lang proposed that the elicitation of a fear emotional response during mental imagery of the feared stimuli (simulation of both perceptual representations and autonomic and behavioral responses) is required for learning to occur, and is therefore necessary in order for imaginal exposure to be effective (Lang, 1977; Wolpe, 1958). Interestingly, Lang's conception of mental imagery as an "as-if real" template parallels contemporary functional perspectives on mental imagery. These contemporary accounts view mental imagery as a core component of the "prospective brain," which enables the simulation of hypothetical future events based on prior knowledge and memories of past experience for the purposes of prediction and planning (Moulton & Kosslyn, 2009; Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007).

Of particular relevance to Lang's (1977, 1979) functional theory is Moulton and Kosslyn's (2009) theory of mental imagery as emulation. Emulation