

Pain Anticipation in the Cingulate Gyrus

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Our ability to anticipate the consequences of motor events, environmental stimuli, or decision processes is a fundamental aspect of consciousness and it offers unique adaptive advantages (Ingvar, 1985). Previous acquired knowledge, in combination with currently available information, provides the basis for understanding as to how we generate anticipatory responses. Anticipation is a highly complex condition where different factors such as attention, preparation and motivation, fear, or anxiety can come into play. Such mechanisms allow anticipatory adaptation and coping with neutral and emotional stimuli, thus influencing subsequent behavior (Lazarus, 1991; Posada *et al.*, 2001). A description of current theories on anticipation is beyond the scope of this chapter (for review, see Kirsch, 1999).

Given its unique role at the interface of cognitive, affective, and motor functions as discussed in Chapters 5 and 8–13, the cingulate cortex is a likely substrate for anticipatory mechanisms. Indeed, physiological and functional imaging studies have disclosed the role of cingulate regions in different experimental models of anticipation. For instance, electrophysiological studies performed in non-human primates have shown anticipatory activity of anterior cingulate neurons during expectation of the visual cue triggering task onset, or during the delay period in delayed response tasks (Niki and Watanabe, 1976, 1979); anticipatory activity of different neurons could be related to orienting attention before stimulus onset, to a preparatory set for emitting appropriate behavioral responses, or to time estimation processes. Other studies have shown cingulate neurons displaying activity related to the degree of reward expectancy (Shidara and Richmond, 2002; Matsumoto, *et al.*, 2003) or to motor preparation depending on an expected reward (Shima and Tanji, 1998; Matsumoto *et al.*, 2003).