Attitudes

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Glossary

Ambivalence The extent to which an attitude is characterized by both positive and negative associations with the target of evaluation.
Attitude A person's evaluation of a particular object, issue, or person that can vary in its positivity or negativity.
Attitude certainty The subjective conviction a person has in the correctness, validity, or clarity of his or her attitude.
Attitude strength A reflection of an attitude's longevity, resistance to persuasion, and ability to predict behavior.
Extremity The degree of positivity or negativity in an evaluation, regardless of valence itself.
Implicit Ambivalence The degree of discrepancy between an attitude as measured via implicit or automatic measures (e.g., the Implicit Association Test) and an attitude as measured via explicit measures (e.g., self-report scales).

Throughout the history of social psychology research, the study of attitudes and attitude-relevant processes has enjoyed steady attention over the last century, providing foundational understanding of how people engage with the world (Briñol & Petty, 2012). Specifically, attitudes refer to a person's evaluations of a target, which can be an object, a place, an issue, oneself, or another person. For example, a person who thinks that Chicago is a great city but who dislikes San Francisco has a positive attitude toward Chicago and a negative attitude toward San Francisco. Attitudes are important because a person's attitude predicts his or her relevant behavior and the way information is processed. Thus, in the previous example, the person is relatively more likely to choose to live in Chicago than to live in San Francisco.

The burgeoning field of social neuroscience has considered a range of topics including fundamental topics in social psychology like social cognition and the self. Likely due to the difficulties in measuring representations in the brain (but see Norman, Polyn, Detre, & Haxby, 2006), research on attitudes has received relatively less attention. Yet, although the representations themselves may be elusive, the implications that these representations have for generating evaluations and biasing cognitive processes are more tangible and have been the focus of neuroscientific study (Cunningham & Zelazo, 2007). For example, research has explored the brain regions associated with several fundamental attitude-relevant processes such as making evaluative (vs. nonevaluative) judgments (e.g., Cunningham, Johnson, Gatenby, Gore, & Banaji, 2003; Cunningham, Raye, & Johnson, 2004; Zysset, Huber, Ferstl, & von Cramon, 2002) and storing summary evaluations in memory (Johnson, Simon, Henkell, & Zhu, 2011; Zysset et al., 2002). We review the existing work on the neuroscience of attitudes, paying particular attention to brain regions that specifically correlate with important attitude-relevant phenomena, focusing on attitude structure and attitude-relevant effects.

We begin by exploring attitude structure and strength, reviewing work identifying distinct neural processes separating positive from negative attitudes and separating potentially strong from weak attitudes. Finally, we review work relating to the antecedents and consequences of attitudes, including processes of attitude change and the effects of attitudes on subsequent information processing and behavior.

The Attitude Itself: Structure and Strength

Valence

Among the most fundamental features of an attitude is its valence. That is, at their most basic, evaluations can be considered reactions to a stimulus that are either positive or negative. Although relatively simple conceptually, a broad range of neuroscience research has uncovered a complex set of findings related to processing stimuli about which people have favorable versus unfavorable attitudes. In particular, research has linked evaluative valence with specific activations in orbitofrontal and striatal regions.

Some would also argue that the amygdala also responds to stimuli of particular valence. Early work demonstrating the amygdala's role in fear and anxiety processes (Davis, 1992; LeDoux, 2000) set the stage for later work suggesting that the amygdala uniquely responds to negatively evaluated stimuli (Berntson, Bechara, Damasio, Tranel, & Cacioppo, 2007; Berntson et al., 2011; Cunningham et al., 2003; Park et al., 2001). Later work, however, has shown that the amygdala also responds to positive (vs. neutral) stimuli (see Zald, 2003, for a review), calling into question the valence specificity of amygdala responses. Instead, as discussed in the next section, the amygdala is more likely involved in the extremity of evaluative responses without a universal bias toward stimuli of a particular valence. However, still other research suggests that the amygdala may still show preferential responding to a particular valence, depending on a person's goals. That is, when evaluation goals highlight the importance of positive information, the amygdala shows greater sensitivity to objects evaluated as positive, whereas the amygdala shows greater sensitivity to negative stimuli when evaluation goals highlight the importance of negative information (Cunningham, Raye, & Johnson, 2005; Cunningham, Van Bavel, & Johnsen, 2008).

First, the orbitofrontal cortex (OFC), an oft-studied region in decision-making processes (Wallis, 2007), has been linked to

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valence processing. For instance, in a study on olfaction, the valence of presented odors was linked to activity in the OFC (Anderson et al., 2003). In particular, subjective pleasantness was negatively associated with activity in lateral and anterior OFC. Research since then has further established the role of the OFC in processing the subjective value of presented stimuli (e.g., Hare, O'Doherty, Camerer, Schultz, & Rangel, 2008; Padoa-Schioppa & Assad, 2008; Plassmann, O'Doherty, & Rangel, 2007). Additionally, much work has demonstrated relationships between medial OFC and evaluations of positive rewarding stimuli and between lateral OFC and evaluations of negative stimuli (Kringelbach & Rolls, 2004). Indeed, by considering a range of positive and negative words that participants themselves evaluated, Lewis, Critchley, Rotshtein, and Dolan (2007) found distinct areas of the OFC related to both positive or negative items, suggesting that positivity and negativity are not best captured by a bipolar model of attitudes (i.e., positivity and negativity are not negatively linearly related; see also Cacioppo, Gardner, & Berntson, 1997). The role of the OFC in valence processing also seems to be unrelated to the mode of attitude object presentation (Cunningham, Johnsen, & Waggoner, 2011).

Striatal areas, too, seem to be important in assessing valence, following from existing neuroeconomic theory linking the ventral striatum to reward and value processing (e.g., Delgado, 2007). For example, in a study examining product preferences and purchasing intentions, self-reported attitudes toward presented products were associated with activity in the nucleus accumbens (NAcc), and this NAcc signal also predicted purchase intentions (Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007). Research on cognitive dissonance has also shown the ventral striatum to relate to dissonance-induced attitude change in free-choice paradigms, suggesting that the attitude change following dissonance represents a true change in the neural computation of value for that stimulus (Izuma et al., 2010; Jarcho, Berkman, & Lieberman, 2011).

Attitude Strength

Although the neural correlates of attitudes' valence are important, there has been a long history in the social psychological study of attitudes documenting the importance of other features of stored evaluations beyond mere valence. *Attitude strength* is one such category of these features (Petty & Krosnick, 1995). In the attitudes and persuasion literature, *strong attitudes* are those that are durable (i.e., relatively stable over time and resistant to direct persuasion) and impactful for judgments and behaviors (Krosnick & Petty, 1995). Researchers have identified many reliable indicators of attitude strength, including accessibility, extremity, importance, ambivalence, and certainty. To date, only some work in neuroscience has considered the neural correlates of attitude strength indicators, calling for continued effort in this domain.

One of the simplest dimensions of attitude strength is *attitude extremity*. Extremity refers to how positive or negative a person's attitude is (Abelson, 1995). For example, someone who thinks that trains are 'very good' has a more extreme attitude than someone who thinks that trains are only 'somewhat good' even though the absolute valence (i.e., positive) is the same. Importantly, extremity is independent of valence such that two people can have equally extreme attitudes even if one person's attitude is positive and the other's is negative. One brain region that has demonstrated particular sensitivity to evaluative extremity is the amygdala.

Early evidence for the amygdala's sensitivity to evaluative extremity (or 'intensity') comes from work on olfaction. In the previously described study linking the OFC with valence, the amygdala was positively associated with the intensity of the odors being delivered but not related to the independently manipulated valence of odors (Anderson et al., 2003). In a more conventional attitudes paradigm, Cunningham, Johnson, et al. (2004) computed extremity scores based on participants' evaluations of visually presented words and found a positive relationship between amygdala activity and the extremity of evaluations (see also Cunningham et al., 2008). Related to evaluative extremity is an 'arousal' component of emotions, suggested to constitute a dimension separate from valence. Indeed, the amygdala is also specifically tuned to arousal ratings of affective words and not the valence of those words (Lewis et al., 2007). Interestingly, however, Berntson et al. (2011) found that patients with insula lesions (compared to controls and amygdala lesions) gave both reduced evaluative valence and arousal ratings to both increasingly positive and negative affective stimuli. Although this work highlights a new region important for attitudinal extremity, the failure for patients with amygdala lesions to show deficits in extremity processing independent of valence means that future research will be needed to explain this discrepancy in the literature.

Another dimension of attitude strength is *attitudinal ambivalence*, which refers to the co-occurrence of positivity and negativity in a person's evaluation (for a review, see Conner & Armitage, 2008). Often, people experience this apparent inconsistency as an uncomfortable feeling of internal conflict (Newby-Clark, McGregor, & Zanna, 2002; Priester & Petty, 1996; van Harreveld, van der Pligt, & de Liver, 2009). Encountering stimuli about which people hold relatively ambivalent attitudes tends to activate the anterior cingulate cortex (ACC), right inferior frontal cortex, OFC, ventromedial prefrontal cortex, and frontopolar cortex (Cunningham et al., 2003; Cunningham, Johnson, et al., 2004; Jung et al., 2008; Nohlen, van Harreveld, Rotteveel, Lelieveld, & Crone, 2013). Additionally, brain regions associated with the subjective feeling of discomfort associated with ambivalent attitudes include the temporal parietal junction and posterior cingulate cortex/precuneus, which both demonstrate a negative correlation with self-reported felt ambivalence (Nohlen et al., 2013).

The role of the ACC in attitudinal ambivalence is consistent with the notion that this brain area is integral to the detection of cognitive conflict (Carter & van Veen, 2007). Indeed, the ACC also plays a key role in another form of social cognitive inconsistency: cognitive dissonance (Kitayama, Chua, Tompson, & Han, 2013; van Veen, Krug, Schooler, & Carter, 2009), lending support to the proposal that attitudinal ambivalence and cognitive dissonance may share fundamental underlying processes (Proulx, Inzlicht, & Harmon-Jones, 2012). Further work should thus examine whether ACC activation accompanies other forms of attitude-relevant inconsistency such as *implicit ambivalence* (i.e., discrepancies between implicit and explicit measures of attitudes toward the same object; Petty & Briñol, 2009; Petty, Briñol, & Johnson, 2012; Petty, Tormala, Briñol, & Jarvis, 2006). In fact, some evidence already suggests this may be the case. In a study where participants were asked to make 'deceptive' explicit attitude reports, ERP results are consistent with the role of the

ACC for trials when explicit attitudes mismatch 'true' attitudes (Johnson, Henkell, Simon, & Zhu, 2008). Because participants were instructed to make deceptive responses, it is unclear whether the ACC response is merely due to the response behavior or whether it might extend to existing attitude representations in which implicit and explicit responses naturally differ. The ACC has already been implicated in the detection and regulation of automatically activated negative racial attitudes (Cunningham, Johnson, et al., 2004; Richeson et al., 2003; for a review, see Stanley, Phelps, & Banaji, 2008), but future work should consider the extent to which this effect extends beyond the domain of prejudice.

A final attitude strength indicator that has inspired widespread interest in attitude research is attitude certainty. *Attitude certainty* refers to the subjective conviction a person has in the correctness, validity, or clarity of his or her attitude (for reviews, see Rucker, Tormala, Petty, & Briñol, 2014; Tormala & Rucker, 2007). To date, little research has considered this influential construct from a neuroscience perspective although work examining the neural underpinnings of memory, judgment, and choice certainty is potentially informative for understanding attitude certainty (Luttrell, Briñol, Petty, Cunningham, & Diaz, 2013). One brain region that has been implicated in both memory (e.g., Chua, Schacter, Rand-Giovannetti, & Sperling, 2006; Moritz, Gläscher, Sommer, Büchel, & Braus, 2006; Simons, Peers, Mazuz, Berryhill, & Olson, 2010) and decision (e.g., De Martino, Fleming, Garrett, & Dolan, 2012; Kiani & Shadlen, 2009) certainty is the medial parietal area. Indeed, preliminary evidence shows that when people report their attitudes toward objects about which they later report to have relatively high attitude certainty, they show brain activity in medial parietal regions corresponding to their level of certainty (Luttrell, Hasinski, & Cunningham, 2013). An additional region that has shown confidence-related neural responses for both memory (e.g., Chua et al., 2006; Schnyer, Nicholls, & Verfaellie, 2005) and decision (e.g., Beer, Lombardo, & Bhanji, 2009; De Martino et al., 2012; Volz, Schubotz, & von Cramon, 2005) certainty is the medial prefrontal cortex (mPFC). It is unclear, however, whether this area is similarly related to evaluative certainty.

Attitude Processes: Antecedents and Consequences

In addition to understanding the elements of a person's attitudes – their valence and indicators of strength – researchers have also considered how attitudes are formed and changed as well as the various outcomes that attitudes predict. Due to the historical importance placed upon understanding these phenomena, research in social neuroscience has begun to understand the neural processes through which attitudes change and predict relevant outcomes.

Regarding attitude change, the OFC and striatal regions appear to be important in this process. New research suggests that the effect of social consensus on attitude change (i.e., that people often adopt attitudes that appear to be widely held; Erb & Bohner, 2001; Festinger, 1954) may be due to changing the value of the attitude object by the OFC and NAcc (Zaki, Schirmer, & Mitchell, 2011). Similarly, when experts agree about the value of a particular object, attitude change is related to the activity in the ventral striatum when receiving the social feedback (Campbell-Meiklejohn, Bach, Roepstorff, Dolan, & Frith, 2010). Anatomical variation in lateral OFC regions also predicts the extent to which one's evaluations are influenced by such social feedback (Campbell-Meiklejohn et al., 2012).

It is noteworthy that although much work in social psychology studies 'persuasion' as processes by which attitudes change (e.g., Petty & Briñol, 2010), research considering persuasion from a social neuroscience perspective has instead tended to examine persuasion as the effects of a message on subsequent behavior (e.g., Chua et al., 2011; Falk, Berkman, Mann, Harrison, & Lieberman, 2010; Falk, Berkman, Whalen, & LIeberman, 2011) or on general ratings of how subjectively 'persuasive' or 'convincing' the messages are (Falk, Rameson, et al., 2010; Ramsay, Yzer, Luciana, Vohs, & MacDonald, 2013). Although these studies do sometimes report regions with activity positively correlated with attitude change (e.g., dorsolateral prefrontal cortex; Falk, Rameson, et al., 2010), future neuroscience research on persuasion could benefit from considering message-induced attitude change as a precursor to subsequent behavior.

With regard to the consequences of attitudes for various outcomes, some research has considered the neural underpinnings of the extent to which attitudes guide information processing and relevant behavior. For instance, Bruneau and Saxe (2010) presented Arab, Israeli, and control participants with a variety of statements characterized as pro-Arab or pro-Israeli, and the participants rated each statement for how reasonable they thought it was. Their neuroimaging results showed that not only the precuneus differentiated between pro-out-group and pro-in-group statements but also its response to pro-out-group (vs. pro-in-group) statements was correlated with both explicitly and implicitly measured negative attitudes toward the out-group. These results suggest that the precuneus may be involved in the extent to which stored evaluations guide information processing.

Additionally, attitude-relevant behavior has also been considered from a neuroscience perspective. At a very simple level, recent research has demonstrated that positive and negative attitudes facilitate approach versus avoidance motor behaviors, respectively, via dorsal premotor cortex and posterior superior parietal areas, regions previously implicated in other learned stimulus–response relationships (McCall, Tipper, Blascovich, & Grafton, 2012). In fact, consistent with hemispheric asymmetries (i.e., left or right hemisphere dominance) associated with tendencies to engage in approach versus avoidance behaviors (e.g., Sutton & Davidson, 1997), processing attitude objects evaluated positively versus negatively, respectively, has been associated with the same hemispheric asymmetries using both EEG and fMRI methodologies (Cunningham, Espinet, DeYoung, & Zelazo, 2005; Sutton & Davidson, 2000; Wood, Romero, Knutson, & Grafman, 2005). In slightly more complex circumstances involving decision-making situations, NAcc activation during product exposure not only correlates with people's attitudes toward those products but also predicts later product choices (Knutson et al., 2007). However, neural patterns not related to evaluations themselves may predict subsequent attitude-relevant behavior. Tusche, Bode, and Haynes (2010), for example, showed that insula and mPFC activation in response to visually presented products predicted later product choices. Interestingly, however, product evaluations were only partially predictive of the relevant choices in this study and no brain areas showed activations strongly correlated with both product evaluations and subsequent choices. Thus, it seems that these areas might be more important for understanding the strength of evaluations (i.e., the extent to which they predict later choices) than for understanding mere attitudinal valence.

Conclusions

The study of attitudes and persuasion has played an integral role in the development of social psychology, developing an understanding of processes with widespread theoretical and practical applicability. Although research in social neuroscience has begun to understand the neural processes underlying attitudes and their effects, the social psychological literature has amassed a rich bank of knowledge from behavioral studies from which future neuroscience researchers should draw. Continued progress towards understanding the neural processing and representation of stored evaluations along with their antecedents and consequences will develop this foundational area of research and have implications for many theoretical advances to come.

See also: **INTRODUCTION TO SOCIAL COGNITIVE NEUROSCIENCE**: Attitude Change and Cognitive Consistency; Exploring the Brain Dynamics of Racial Stereotyping and Prejudice; Social Influence and Persuasion and Message Propagation; **INTRODUCTION TO SYSTEMS**: Emotion.

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