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Cooperative versus competitive influences of emotion and cognition on decision making: A primer for psychiatry research

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ABSTRACT

Clinical research across the developmental spectrum increasingly reveals the nuanced ways in which emotion and cognition can work to either support or derail rational (i.e., healthy or goal-consistent) decision making. However, psychological theories offer discrepant views on how these processes interact, and on whether emotion is helpful or harmful to rational decision making. In order to translate theoretical predictions from basic psychology to clinical research, an understanding of theoretical perspectives on emotion and cognition, as informed by experimental psychology, is needed. Here, I review the ways in which dual-process theories have incorporated emotion into the process of decision making, discussing how they account for both positive and negative influences. I first describe seven theoretical perspectives that make explicit assumptions and predictions about the interaction between emotion and cognition: affect as information, the affect heuristic, risk as feelings, hot versus cool cognition, the somatic parker hypothesis, prospect theory, and fuzzy-trace theory. I then discuss the conditions under which each theoretical perspective conceptualizes emotion as beneficial or harmful to decision making, providing examples from research on psychiatric disorders.

1. Introduction

Decision making is impaired in many psychiatric disorders (Paulus, 2007; Paulus and Yu, 2012). The more researchers understand the neural, molecular and genetic mechanisms of these disorders, the clearer it becomes that cognitive and emotional function are closely intertwined during the decision making process (Okon-Singer et al., 2015). Evidence-based theories, which are updated iteratively based on the results of hypothesis testing, can efficiently summarize decades of basic psychological research, providing a valuable tool for hypothesis generation when translated to the clinical domain. However, psychological research supports multiple theoretical perspectives, which have nuanced and sometimes opposing views on how emotion interacts with cognition and influences decision making. In order to facilitate the translation of psychological theory to clinical research, this review aims to provide an overview of theoretical accounts of emotion–cognition interactions and the influence of these interactions on decision making, both in healthy individuals and in individuals with psychiatric disorders. When discussing effects on decision making, I use “rational” or “positive” to refer to goal-consistent, healthy, or adaptive decision making (Reyna and Farley, 2006).

People with psychiatric disorders experience both subjective and objective impairments in decision making. Subjectively, they report distress while making decisions; this distress is especially pronounced in individuals with autism (Luke et al., 2011) and schizophrenia (Candilis et al., 2008). Objectively, people with psychiatric disorders make decisions that are sub-optimal along multiple dimensions, including taking too few or too many risks (Rahman et al., 2001); failing to learn from feedback (Cella et al., 2010; Chiu et al., 2018; Piazzagalli et al., 2008); failing to gather sufficient evidence before making decisions (Dudley et al., 2016; So et al., 2016); preferring smaller immediate gains to larger later gains (Gleichgerrcht et al., 2010); and being averse to short-term losses (Maner and Schmidt, 2006; Mueller et al., 2010), even when they are advantageous in the long-term (Chiu et al., 2018; Shurman et al., 2005). Theoretical approaches to emotion–cognition interactions provide insight into the mechanisms of altered decision making in these disorders.

Two dimensions of emotion, valence (i.e., positive versus negative) and arousal (i.e., calming versus exciting, usually with a physiological component), have proved useful in measuring abnormalities related to psychiatric disorders. Some psychiatric disorders are characterized by abnormal processing of valence (i.e., sensitivity to reward or loss; De Martino et al., 2008; Disner et al., 2011; Paulus and Yu, 2012) and arousal (i.e., physiological activation; Chiu et al., 2018; Storbeck and Clore, 2008). Regarding valence, people with depression and anxiety show attentional and other processing biases toward negatively

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valenced information (Gasper and Clore, 2002; Paulus, 2007; Paulus and Yu, 2012), and those with depression show diminished processing of positively valenced information (i.e., an "affective blockade;" Disner et al., 2011; Piazzagalli et al., 2008). Higher anxiety is associated with increased loss aversion (Gasper and Clore, 1998; Maner and Schmidt, 2006; Mueller et al., 2010). Regarding arousal, somatic reactivity during decision making is increased in anxiety (Miu et al., 2008; Werner et al., 2009) but is diminished in depression (Paulus, 2007) and anorexia nervosa (Tchanturia et al., 2007). Additionally, people with autism spectrum disorder show diminished anticipatory somatic response decision information such as reward and risk (De Martino et al., 2008) but increased somatic response to reward feedback (Faja et al., 2013).

In addition to emotional processing, some psychiatric disorders are also characterized by atypical cognitive representations of decision-relevant information, including risk (Gasper and Clore, 1998; Gleichgerrcht et al., 2010; Weber, 2010), evidence gathering (Dudley et al., 2016; McLean et al., 2017), and tolerance for uncertainty or ambiguity (Bar-Anan et al., 2009; Smith et al., 2016). Depressed individuals tend to be risk-averse (Smoski et al., 2008), whereas individuals with frontotemporal dementia tend to be risk-seeking (Gleichgerrcht et al., 2010; Rahman et al., 2001). Individuals with schizophrenia tend to make decisions based on less evidence than healthy counterparts (McLean et al., 2017), and individuals with anxiety typically have a low tolerance for ambiguity (Dugas et al., 1998).

In the following sections, I first provide an overview of mechanisms by which emotion can interact with cognitive processing and influence decision making in both healthy individuals and those with psychiatric disorders. I then introduce a class of theories called dual-process theories, which distinguish between a fast, automatic form of cognition (often incorporating emotion) and a slow, deliberative form of cognition (often, but not exclusively, associated with rational decision making). Next, I introduce seven theoretical perspectives, describing each theory's account of how emotion and cognition interact during decision making. I then review predictions by each theory as to whether, and under which conditions, emotion supports rational (i.e., goal-consistent) decision making. For each set of theoretical predictions, I discuss relevant findings from research on psychiatric disorders.

2. Mechanisms by which emotion influences decision making

The seven theories described below assume four mechanisms by which emotion influences decision making. First, processing of affectively relevant information can be more rapid than processing of information devoid of emotional content. This can result in a perceptual filter that prioritizes cognitive processing of affective information (Markovic et al., 2014; see also Barrett and Bar, 2009). In this way, affect can act as a "spotlight," focusing attention on selective aspects of the decision information (Peters, 2006). This not only influences which aspects of current decision options are emphasized; it also reinforces this selective focus in memory, which affects inputs to future decisions.

Second, emotion may provide unique (and often beneficial) information compared to rational analysis. The affect-as-information hypothesis (Clore et al., 1994; Schwarz and Clore, 2003) posits that feelings serve as inputs to decision processes; this can be beneficial when the feelings reflect expertise, but it can be misleading when incidental emotions are mistakenly attributed to the options at hand. As an example, Peters and colleagues have argued that numerical information about risk is most easily interpreted when it is grounded in emotional meaning: "Without affect, information appears to have less meaning and to be weighed less in judgment and choice processes" (Peters, 2006). This positive effect of emotion on decision making has been described as "affective rationality" (Slovic et al., 2002). Another example of the beneficial role of affective information is described by the somatic marker hypothesis (Bechara and Damasio, 2005), according to which visceral sensations (i.e., physiological arousal) warn against dangerous options or orient toward advantageous options.

Third, emotions provide an efficient way to process large amounts of complex information. For example, the affect heuristic (described in detail below) describes feelings as a substitute for processing more complex information about decision options. Because affect is highly accessible, this is produces a decision with minimal cognitive effort (Kahneman, 2003). Additionally, feelings about decision options may provide a common currency across which multiple attributes may be efficiently compared (e.g., Montague and Berns, 2002).

Fourth, certain dimensions of emotion, including valence and arousal, may influence the type of cognitive processing that is used. For example, positive affect has been associated with more global, holistic thinking, whereas negative affect has been associated with more detailed, analytical thinking (e.g., Fredrickson, 2001; Rowe et al., 2007). Additionally, false memories may be more frequent under conditions of high arousal (Corson and Verrier, 2007) and negative valence (Brainerd et al., 2008). Effects of distinct emotional states are evident in phenomena such as mood-congruent processing, in which the specific emotion experienced during decision making affects the outcome of that decision (see review by Phelps et al., 2014; for an example of mood-congruent perception, see Anderson et al., 2011). The influence of emotion on cognitive states is also addressed by the distinction between hot and cool cognition (described below).

3. Dual-process theories

Dual-process theories refer to a class of cognitive theories that distinguish between a fast, automatic form of cognition and a slow, deliberative form of cognition. As Evans (2008) and Evans and Stanovich (2013) point out, there are many versions of this distinction. Stanovich and Toplak (2012) identifies 23 such theories; Evans (2008) provides a detailed summary of 14 of them. However, Evans and Stanovich (2013) argue that all of these theories attribute a core set of defining features to each type of processing. They argue that there is consensus on the following defining features: An intuitive "Type 1" process that is autonomous (i.e., does not compete with other processes for cognitive resources) and is therefore independent of working memory capacity, and a reflective "Type 2" process that requires "cognitive decoupling" (i.e., meta-cognition resulting in reflection on one's own cognitive processes) and is dependent on working memory resources. I will follow the convention proposed by Evans and Stanovich (2013) and refer to intuitive and deliberative processing as Type 1 and Type 2, respectively.

In addition to these defining features, Evans (2008) and Evans and Stanovich (2013) describe a set of attributes that are associated with each process by some versions of dual-process theory. For example, some theories differentiate Type 1 processing from Type 2 processing by describing them as fast versus slow, parallel versus serial, automatic versus controlled, unconscious versus conscious, high-capacity versus capacity-limited, holistic versus analytic, and automatic versus controlled. Theories that incorporate individual differences in cognitive ability generally assume that Type 1 processing is independent of cognitive ability, and that Type 2 processing is more reflective of individual differences in cognitive ability, such as working memory capacity (Evans and Stanovich, 2013; see also Frederick, 2005).

Evans and Stanovich also distinguish between two major classes of dual-process theory: parallel-competitive (e.g., Sloman, 1996) and default-interventionist (e.g., Kahneman and Frederick, 2002). According to parallel-competitive theories, Type 1 and Type 2 processing occur simultaneously and in parallel; if they produce conflicting decisions, the conflict must then be resolved (often by System 2, though some theories allow for a separate inhibitory process; see also De Neys, 2012; De Neys et al., 2010). In contrast, according to default-interventionist theories, Type 1 processing occurs by default, and Type 2 processing can intervene to correct behavior under specified conditions. That is, "most behavior will accord with defaults, and intervention will occur only when difficulty, novelty, and motivation combine to command the resources of working memory" (Evans and Stanovich, 2013, p. 237). Evans (2010) further explains, "intervention on intuitions by reasoning requires both the cognitive capacity for the relevant reasoning and the awareness of the need for doing so" (p. 323). Evans and Stanovich favor the default-interventionist approach.

Based on this distinction, many scholars have attributed sub-optimal decision making to Type 1 processing, and rational or adaptive decision making to Type 2 processing. However, this is not a core assumption of dual-process theories. Indeed, Evans and Stanovich (2013) caution against the interpretation of default-interventionist models as implying that Type 1 processing is inferior to Type 2: "Perhaps the most persistent fallacy in the perception of dual-process theories is the idea that Type 1 processes (intuitive, heuristic) are responsible for all bad thinking and that Type 2 processes (reflective, analytic) necessarily lead to correct responses" (Evans and Stanovich, 2013, p. 229). Thus, although many dual-process theories treat errors or biases as synonymous with Type 1 processing, this assumption is not a defining feature of Type 1 processing. Consistent with this point, Kahneman and Frederick (2007) describe both "System 1 rationality" and "System 2 rationality," indicating the belief that either type of cognition can produce rational decisions.

I now briefly review how dual-process theories integrate emotion with cognitive processing, and how they account for both positive and negative influences of emotion on decision making. Loewenstein et al. (2001) distinguish between *anticipatory emotions*, which are "visceral" reactions to decision alternatives that can serve as information about these options (Kuhnen and Knutson, 2005); and *anticipated emotions*, which are the emotional states that a decision maker imagines as the hypothetical outcome of each decision alternative. To the extent that dual-process theories have incorporated emotion, they have focused primarily on anticipatory emotions, which are often measured as increased physiological arousal prior to sub-optimal decision outcomes (for a review, see Naqvi et al., 2006; but see Gladwin and Figner, 2014, for an exception). I describe seven ways in which dual-process theories have explicitly incorporated emotion: affect as information (Schwarz and Clore, 2003), the affect heuristic (Slovic et al., 2007), risk as feelings (Loewenstein et al., 2001), hot versus cool cognition (Gladwin and Figner, 2014; Metcalfe and Mischel, 1999), the somatic marker hypothesis (Bechara and Damasio, 2005; Naqvi et al., 2006), prospect theory (Kahneman and Tversky, 1979), and fuzzy-trace theory (Reyna and Brainerd, 2011). I then discuss ways in which these theories interpret the influence of emotion as beneficial or harmful to decision making.

4. Theoretical accounts of emotion and cognition

4.1. Affect as information, the affect heuristic, and risk as feelings

According to the affect-as-information hypothesis, affective states, ranging from physiological arousal to discrete mood states, can be attributed to decision information and can therefore influence judgments about decision options (though this effect is diminished by drawing conscious awareness to this attribution; see review by Schwarz and Clore, 2007). Similarly, the affect heuristic (Epstein, 1994) describes the process by which feeling states help decision makers to attribute a quality of "goodness" or "badness" to different options. According to this perspective, decision makers' visceral reactions to decision options may serve as input to decisions. Slovic et al. (2002, 2007) describe a particular affect heuristic, "risk as feelings." According to this theory, intuitions about risky decisions are linked to previous experience by feelings or affective states (e.g., the feeling that crossing a dark street is "good" or "bad" may be influenced by the safety of the neighborhood in which one grew up).

The affect-as-information hypothesis allows for both positive and negative effects of emotion on decision making: "Feelings can serve as a basis of accurate as well as mistaken inferences, depending on the relationship between the feeling and the target" (Schwarz and Clore, 2007, p. 4). According to this framework, whether feelings are helpful or harmful to decision making depends on whether the decision maker attributes the feelings to the correct source. For example, according to the mood congruence effect, internal feeling states may be attributed to external stimuli (e.g., decision options), such that the stimuli will be imbued with more positive characteristics if the decision maker is in a more positive mood. If the objective valence of the decision options matches the mood of the decision maker, then this misattribution is benign and may even increase the likelihood of a good decision. However, if there is a mismatch between the objective features of the decision options and the decision maker's feeling state, this misattribution could result in a suboptimal decision. By realizing that one's feelings are unrelated to decision information and correctly attributing them to unrelated cause, one can avoid influencing the decision.

Mood congruence features prominently in depression and other mood disorders. Individuals with depression show less amygdala response to happy faces, but more amygdala response to sad faces, than do healthy counterparts (Suslow et al., 2010). Compared to healthy counterparts, depressed individuals are also less likely to respond to happy than to sad words, and when they do respond to happy words, they take longer to do so than when responding to sad words (Erickson et al., 2005). Individuals with anxiety also display attentional, interpretational, appraisal, and memory biases toward negative stimuli (Mathews and MacLeod, 1994, 2005).

Although psychiatric disorders are distinct from mood (which can be shorter-term and more transient), research on mood disorders has identified biases in processing information about the past, present, and future. Regarding the past, a meta-analysis found that people with depression tend to over-generalize autobiographical memories (Sumner et al., 2010). Regarding the present, a recent meta-analysis found that individuals with depressed mood (whether clinically depressed or healthy individuals experiencing increased depressive symptoms) interpret ambiguous stimuli more often as negative, and less often as positive, than individuals with healthy mood (Everaert et al., 2017). Regarding the future, Maroquín and Nolen-Hoeksema (2015) found that the tendency to use emotion as information accounted for differences in future-oriented cognition between depressed and healthy participants. Specifically, dysphoric participants estimated future negative events as more likely to occur, and future positive events as less likely to occur, than did healthy participants. Participants with dysphoria also estimated that they would feel less happy about future positive events than did healthy participants (with no differences in affective forecasting for negative events; i.e., affective forecasting). Moreover, regarding tendency to use affect as information, dysphoric individuals were more likely to rely on negative feelings, and less likely to rely on positive feelings, than were healthy participants. This differential use of affect as information partially mediated the group differences in estimates of future event likelihood and affective forecasting.

Similarly to affect-as-information, the affect heuristic allows for both positive and negative effects of emotion on decision making. Slovic et al. (2002) argue that the affect heuristic is beneficial when experience allows one to make an accurate prediction about the outcome of alternative decisions (a prediction that is facilitated by affective cues), but that the affect heuristic would be harmful when one has insufficient experience to make an accurate prediction, or when the outcome contingencies have changed relative to one's experience. This prediction is consistent with evidence that individuals with depression or anxiety show deficits in updating their beliefs and predictions based on recently experienced outcomes (Huys and Dayan, 2009; Paulus and Yu, 2012).

The risk-as-feelings hypothesis also allows for both positive and negative effects of emotion on decision making. According to this account, decision making is generally improved by incorporating affective information. Slovic and colleagues argue, "Studies have demonstrated that analytic reasoning cannot be effective unless it is guided by emotion and affect….Both systems have their advantages, biases, and limitations" (2007, p. 311). One limitation of affective reasoning is that it may encourage decision makers to place reduced emphasis on probability (i.e., probability neglect; Rottenstreich and Hsee, 2001; Slovic et al., 2002; see review by Slovic and Peters, 2006). For example, individuals who are hypervigilant to threat (such as those with anxiety) might over-weight the possibility of a large negative outcome, even if the probability of this outcome is low (MacLeod and Mathews, 2012; Maner and Schmidt, 2006). Variations in state anxiety also predict healthy individuals' risk estimates. When healthy people are in a state of high anxiety, their risk estimates increase. For individuals with low trait anxiety, this effect is eliminated when the individual attributes their anxious state to a source that is irrelevant to the risk estimate (Gasper and Clore, 1998). However, attributing the anxious state to a source irrelevant to the risk judgments did not decrease risk estimates in individuals with high trait anxiety. Clore et al. (2001) have interpreted this as suggesting that highly anxious individuals may be unable to distinguish between relevant and irrelevant feelings of anxiety.

4.2. Hot versus cool cognition

This theoretical approach distinguishes a system that is driven by motivational, affective, or approach tendencies (i.e., hot cognition) from a system that is driven by rational analysis (i.e., cool cognition). In a review of this terminology, Gladwin and Figner (2014) describe hot processing as "affect-charged," and cool processing as "affect-free" (p. 3). The hot–cool terminology originated with Abelson (1963), who argued, in contrast to contemporary information-processing approaches to cognition, that affective information contributed unique value to decision making: "The ability of belief systems [i.e., hot cognition] to stir and express the passions of believers is an essential feature not to be found in knowledge systems [i.e., cool cognition]…." (Abelson, 1979, p. 364).

Metcalfe and Mischel (1999) define hot cognition as "the basis of emotionality…impulsive and reflexive" (p. 3); in contrast, they define cool cognition as "cognitive, emotionally neutral…the seat of self-regulation and self-control" (p. 3). As suggested by these definitions, the distinction between hot and cool cognition is often invoked to explain failures of self-regulation, such as the failure to delay gratification. Successful delay of gratification is attributed to cool cognition, as supported in part by self-reported strategies for self-regulation (Mischel et al., 1972). In support of this interpretation, manipulations to invoke "hot" processing often produce impulsive behavior or impair self-regulation, whereas manipulations to invoke "cool" processing often reduce impulsive behavior or enhance self-regulation (Casey et al., 2011; Chick, 2015; Figner et al., 2009).

One characteristic of hot processing is increased arousal, which can convey information about urgency or importance (Storbeck and Clore, 2008). Arousal-induced risk taking can be beneficial in survival contexts (e.g., jumping out the window of a burning house might risk a broken leg but increase chances for survival). However, research on the hot–cool framework has not highlighted this adaptive role of emotion.

Instead, research has identified differential information use in cool versus hot contexts. For example, Markiewicz and Kubinska (2015) demonstrated that people rely on different information in cool as opposed to hot contexts. In particular, people assigned different decision weights to valence and probability when they are in cool versus hot contexts. In the cool condition, they incorporated information about gain, loss and probability into decisions. In the hot condition, they based decisions only on the probability of gain or loss. Additionally, scores on the Cognitive Reflection Test, a measure of system 2 processing, correlated with decisions in the cool condition but not in the hot condition. Relatedly, Penolazzi et al. (2012) showed that personality traits influence decision making differently in cool versus hot contexts. Higher impulsivity was associated with increased risk taking in cool contexts, whereas higher reward responsiveness was associated with sensitivity to gains and losses in hot contexts.

4.3. Somatic marker hypothesis

According to the somatic marker hypothesis (Bechara and Damasio, 2005), decision makers experience visceral cues that guide them toward advantageous options or away from disadvantageous ones. For example, anticipatory physiological arousal has been observed in experienced (but not inexperienced) drivers when viewing road hazards (Kinnear et al., 2013), consistent with a role for emotional arousal in supporting rational decision making. These cues, which are typically unconscious, fall within the arousal dimension of emotion processing. The somatic marker hypothesis assumes two systems: a more affectively driven system that is "important for triggering emotional responses," and a more cognitively driven system that retrieves relevant information from memory for use during "deliberation" (Reimann and Bechara, 2010, p. 769). This first system, driven by subcortical processing, is concerned with "the immediate prospects of an option," whereas the second system, supported by the prefrontal cortex, is concerned with "weighing the future consequences" (Reimann and Bechara, 2010, p. 770). Reimann and Bechara note that the somatic marker hypothesis is conceptually similar to two other dual-process theories: risk as feelings (Loewenstein et al., 2001) and anticipatory affect (Kuhnen and Knutson, 2005).

Evidence for the somatic marker hypothesis comes from experiments using the Iowa Gambling Task (Bechara et al., 2005; for a critique, see Dunn et al., 2006). In this task, individuals iteratively select a card from one of four decks. The cards reveal either gains or losses of various magnitudes and probability. Some decks have contain smaller rewards but are advantageous in the long run, whereas others contain larger rewards but are less advantageous in the long run. Healthy people experience anticipatory visceral responses (i.e., somatic markers), which are associated with learning which decks are advantageous in the long term. Such anticipatory responses are absent in ventromedial prefrontal cortex lesion patients, who also show deficits in real-life emotional decision making (but not general cognitive deficits; for a review, see Naqvi et al., 2006).

Since the somatic marker hypothesis arose from research demonstrating decision making deficits based on failure to process emotional information, much of the theory has focused on the beneficial role of emotion in decision making. However, the theory itself allows for both positive and negative effects of emotion on decision making. Reimann and Bechara (2010) argue, "Although most of the previous work in connection with somatic marker theory argued for the beneficial role of emotions in decision-making, unquestionably there are conditions under which emotions can be disruptive to decision making (p. 773). They continue, "It is not a simple matter of trusting biases and emotions as the necessary arbiter of good and bad decisions. It is a matter of discovering the circumstances in which biases and emotions can be useful or disruptive" (pp. 773–772).

In healthy people, mood and personality predict behavior on the Iowa Gambling Task. People in a negative mood, as well as those high in behavioral activation and sensation seeking, tend to choose more often from a deck that has infrequent losses but is disadvantageous long-term, and less from a deck that has infrequent losses and is advantageous long-term (Buelow and Suhr, 2013). Additionally, higher trait anxiety is associated with poorer decision making (more choices from the long-term disadvantageous decks than from the long-term advantageous decks), despite also being associated with higher physiological arousal prior to advantageous trials (Miu et al., 2008).

Decision making and/or anticipatory physiological arousal during the Iowa Gambling Task are impaired in numerous psychiatric disorders, including depression (Cella et al., 2010), autism (Faja et al., 2013), attention-deficit hyperactivity disorder (Garon et al., 2006), anorexia nervosa (Tchanturia et al., 2007), schizophrenia (Shurman et al., 2005), and fronto-temporal dementia (South et al., 2014). Decision making on the task is not impaired in all psychiatric disorders, however: People with generalized anxiety disorder learn to avoid long-term disadvantageous decks more quickly than healthy people (Mueller et al., 2010), which might be facilitated by a higher anticipatory skin conductance response (Miu et al., 2008).

4.4. Prospect theory

According to prospect theory, decisions are informed by a value function in which the subjective value of gains or losses changes nonlinearly with increasing magnitude. Moreover, the slope of the value function depends on the valence (gain or loss). The slope of the curve is steeper for losses than for gains, meaning that a loss feels larger than a gain of the same objective magnitude. Additionally, both magnitude and probability exhibit diminishing returns, such that the difference between 0 and 1 feels larger than the difference between 99 and 100.

Given the central role of valence in determining subjective value, Kahneman (2003) describes affect as an essential component of the value function: “The value function presumably reflects an anticipation of the valence and intensity of the emotions that will be experienced at moments of transition from one state to another” (p. 464; see also Charpentier et al., 2016). Although the word “emotion” does not appear in early papers on prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981), recent iterations of prospect theory have described emotion as a defining feature of this value function: “Utility cannot be divorced from emotion” (Kahneman, 2003, p. 464). Kahneman (2011) elaborates, “humans described by prospect theory are guided by the immediate emotional impact of gains and losses” (p. 287). According to Kahneman (2003), emotional information is incorporated into type 1 processing in the form of an affect heuristic, such that “a basic affective reaction can be used as the heuristic attribute for a wide variety of more complex evaluations, such as the cost/benefit ratio of technologies, the safe concentration of chemicals, and even the predicted economic performance of industries” (p. 470). Kahneman describes prospect theory as consistent with a competitive-interventionist dual-process model, in which the affect heuristic is associated with Type 1 processing.

According to prospect theory, emotion provides input to the value function and, as such, helps decision makers to maximize utility. Kahneman (2003) elaborates, “A theory of choice that completely ignores feelings such as the pain of losses and the regret of mistakes is not only descriptively unrealistic. It also leads to prescriptions that do not maximize the utility of outcomes as they are actually experienced” (p. 465). This ascribes a positive role to emotion (and, by extension, Type 1 processing) in decision making. However, according to Kahneman's competitive-interventionist dual-process model, when a reasoning error occurs, it originates in Type 1 processing and persists only if Type 2 processing fails to identify and correct it.

Loss aversion and risk aversion are two aspects of prospect theory that are relevant to decision making in mood disorders. Loss aversion refers to the phenomenon that losses loom larger than gains of the same magnitude. This tendency is exaggerated in people with anxiety or depression, who show attentional and memory biases for negative information (Mathews and MacLeod, 1994, 2005). Regret theory, an economic theory related to prospect theory, is also relevant to mood disorders. Regret arises when people compare a chosen outcome with a counterfactual alternative outcome, and the counterfactual outcome is superior (Loomes and Sugden, 1982). The opposite of regret is rejoicing, which occurs when the chosen outcome is superior to the counterfactual outcome. Regret is often felt more strongly than rejoicing (see Weber, 2010). Many people with depression engage in rumination, a practice of re-imagining or re-examining a past negative event, often with regret (Nolen-Hoeksema, 2000). Biases for negative information and regretful rumination are extreme versions of common behaviors that are described by prospect theory and the related regret theory.

Risk aversion describes the phenomenon that outcomes with probabilities 0 or 1 are weighted more heavily than are approximately equal outcomes that lack certainty (Kusev et al., 2009). In other words, the difference between 0 probability and 0.1 probability feels larger than the difference between 0.5 probability and 0.6 probability because the first pair offer an alternative between certainty and uncertainty, even though the absolute difference is the same in both pairs (see Weber, 2010). People typically prefer certain to uncertain outcomes, but people with anxiety (Maner and Schmidt, 2006) and depression (Smoski et al., 2008) show higher discomfort in the face of uncertainty (Paulus and Yu, 2012).

4.5. Fuzzy-trace theory

The core assumption of fuzzy-trace theory (FTT) is that cognition operates via two parallel processes: verbatim representations, which constitute precise, literal representations of information, and gist representations, which capture the bottom-line meaning of information (Reyna and Brainerd, 2011). Whereas verbatim representations are literal, gist-based representations are more easily mapped onto emotional features such as valence and arousal (Chick and Reyna, 2012; Reyna and Farley, 2006). According to FTT, then, emotion can more readily influence decision making to the degree that gist-based processing is emphasized. Feeling states can also influence the gist extracted from a stimulus (Rivers et al., 2008). Moreover, elements of emotion, such as valence and arousal, are differentially associated with gist versus verbatim processing. For example, a state of high arousal encourages gist extraction during initial memory encoding (at the expense of verbatim details; Kensinger, 2004). Similarly, negative arousal is associated with memory for the gist of information (Adolphs et al., 2001; Reyna and Kiernan, 1994).

Whereas some other dual-process theories characterize intuition as an affective impulse (and therefore as error producing), FTT makes a distinction between gist-based intuition and impulsivity. According to FTT, gist-based intuition is a form of cognitive processing that can be emphasized or de-emphasized within individuals, whereas impulsivity is a trait that is present to a greater or lesser extent across individuals. FTT predicts that decision-making is more susceptible to impulses when verbatim processing is emphasized, because gist processing facilitates access to emotional responses (distinct from impulses) that are protective against unhealthy risk taking. Consistent with this prediction, a study of adolescent decision makers found that retrieval cues triggering gist processing were associated with decreased intentions to have sex, sexual behavior, and number of sexual partners (Reyna et al., 2011).

As described above, FTT posits that emotion is more likely to influence decision making to the extent that cognitive processing relies on gist-based intuition. This leads to the prediction that decision cues, such as the way a question is asked, can encourage either gist or verbatim processing, and can thereby determine the degree to which emotion is accessed during a decision. Consistent with this prediction, when questions about risk were phrased in a way that encouraged gist processing, higher risk perception was associated with lower risk taking among adolescents (Mills et al., 2008). When questions encouraged verbatim processing, higher risk perception was associated with higher risk taking.

Therefore, according to FTT, the influence of emotion on decision making is neither inherently positive nor inherently negative. Rather, the context in which a decision is made (e.g., the wording of a question, or the framing of options) affects the degree to which emotion influences decision making based on the degree to which gist processing is emphasized. A greater emphasis on gist processing will support a stronger influence of emotion, and the emotional reaction may support goal-consistent decisions (e.g., when values such as the desire to pursue education outweigh the immediate desire to have unprotected sex and risk becoming pregnant). However, aspects of emotional processing, such as arousal, can support risk taking; for example, high arousal states often encourage impulsive risk taking, particularly during adolescence (Reyna and Farley, 2006). In contrast, FTT predicts that verbatim processing (i.e., multiplying risk by reward) is likely to encourage unhealthy risk taking. When a negative outcome is highly unlikely (e.g., the chance of getting pregnant from one episode of unprotected sex), the perceived benefits often outweigh the risks (i.e., a "reasoned route" to risk taking; Reyna and Farley, 2006; Rivers et al., 2008).

The relevance of gist processing to emotional aspects of decision making is supported by research on autism. Autism is characterized by attention to detailed information (i.e., verbatim processing) at the expense of global coherence (i.e., gist processing; Frith and Happe, 1994). In one study, adults with autism were less influenced by valence (i.e., gain or loss) than were control adults when making risky decisions (De Martino et al., 2008). This reduced sensitivity to valence was accompanied by a smaller difference in skin conductance response to losses compared to gains in adults with autism (who showed no difference) versus control adults (who showed a higher skin conductance response to losses than to gains). These results suggest that adults with autism are less sensitive to the valence aspect of emotion than are control adults, as evidenced both by less physiological arousal and a diminished influence on risky decision making.

5. Discussion

In the preceding sections, I reviewed theoretical accounts of the mechanisms by which cognition and emotion interact, with an emphasis on relevance to psychiatric disorders. I began by describing subjective and objective difficulties that people with psychiatric disorders experience during decision making. These include subjective distress, taking too few or too many risks, failing to learn from feedback, failing to gather sufficient evidence, and preferring smaller immediate gains to larger later gains. Additionally, psychiatric disorders are associated with biases in processing decision-relevant aspects of emotion, including valence and arousal.

I next reviewed four basic mechanisms by which emotion and cognition interact. First, processing of affectively relevant information is privileged in that it can be more rapid than processing of information devoid of emotional content. Second, emotion may provide unique (and often beneficial) information compared to rational analysis (e.g., the affect-as-information hypothesis; the somatic marker hypothesis). Third, emotions provide an efficient way to process large amounts of complex information (i.e., a "common currency;" e.g., the affect heuristic). Fourth, distinct aspects of emotion, including valence and arousal, may influence the type of cognitive processing that is used (e.g., positive affect is associated with global thinking; high arousal and negative valence are associated with false memories; mood-congruent processing; the hot–cold hypothesis).

I then introduced seven theoretical perspectives and explained their accounts of emotion–cognition interaction. These theories differ with respect to their treatment of emotion within the construct of "type 1" thinking. The affect as information, affect heuristic, risk as feelings, and hot versus cold cognition hypotheses, as well as prospect theory, all describe emotion as a defining feature of Type 1 processing. In summarizing the affect-as-information, affect heuristic, and risk as feelings hypotheses, Slovic and Peters (2006) describe affect as a defining feature of Type 1 processing: "One of the main characteristics of the intuitive, experiential system is its affective basis" (p. 322). Similarly, Kahneman (2003) argues that emotional information contributes to Type 1 processing because it is easily accessible. Kahneman describes affect as a fundamental source of heuristic information: "In terms of the scope of responses that it governs, the natural assessment of affect should join representativeness and availability in the list of general-purpose heuristic attributes" (p. 470). Similarly, "hot" cognition, which Metcalfe and Mischel (1999) describe as "emotional," "simple," "reflexive," and "fast," overlaps almost entirely with the features of Type 1 processing as described by Evans and Stanovich (2013). Finally, to the extent that somatic marker theory fits into the dual-process framework, the role it ascribes to emotion (i.e., supporting "specific approach or withdrawal behaviors" and considering the "immediate prospects of an option," Reimann and Bechara, 2010, p. 770) is consistent with Type 1 processing. Therefore, the somatic marker hypothesis joins affect as information, the affect heuristic, risk as feelings, prospect theory, and hot versus cold cognition in describing emotion as a defining feature of Type 1 processing.

In contrast, other dual-process theories treat emotion as incidental to Type 1 and Type 2 processing. Evans (2008) notes, "it is clear that emotional processing would be placed in the System 1 rather than the System 2 list" (Evans, 2008, pp. 256–257). Other dual-process theories acknowledge the potential for emotion to influence decision making but do not consider the influence of emotion to be a defining characteristic of intuitive (Type 1) processing. As Darlow and Sloman (2010, p. 385) argue, "While affect may be an essential property or heuristic of intuitive decision making, there is little evidence of it at this point." Evans and Stanovich (2013) acknowledge that some theories may incorporate aspects of emotion into Type 2 processing, but they do not specify any such theories. Notably, the association of emotion with Type 2 processing is not characteristic of dual-process theories; instead, dual-process theories tend to associate emotion with Type 1 processing, when they consider it at all.

Nearly all of the theories reviewed here assume that emotion can either support or confound rational decision making, depending on the characteristics of the decision maker and the context of the decision. Examples from psychiatric research demonstrate that the paradigms validated in healthy subjects can also elucidate mechanisms of behavior in psychiatric disorders (Baldois and Potenza, 2015; Knutson and Heinz, 2015; Schneider et al., 2012; Samanez-Larkin and Knutson, 2015; Whelan et al., 2012).

Three themes emerge from the foregoing review of psychological theories as applied to research on psychiatric disorders. First, context is relevant when determining how emotion and cognition interact. For example, the hot–cool hypothesis predicts that information presented in a hot context, as opposed to a cool context, is more likely to elicit emotional contributions to decision making. Similarly, fuzzy-trace theory predicts that emotion is more readily incorporated in decision making when gist processing is cued. Second, certain psychiatric disorders affect processing of decision-relevant information, including risk, with effects that are consistent with predictions by psychological theories. For example, people with anxiety are highly risk-averse, whereas people with frontotemporal dementia or addiction are risk-seeking, consistent with the risk-as-feelings hypothesis.

Third, certain psychiatric disorders affect aspects of emotion processing that affect decisions in ways predicted by psychological theories. People with anxiety experience hyperarousal, which is sometimes beneficial to risk taking, as predicted by the somatic marker hypothesis. Valenced biases are also common; for example, people with depression and anxiety are over-sensitive to negative emotion (showing an attentional and memory bias for negative emotion, as well as decreased sensitivity to positive emotion). In contrast, people with autism are indifferent to valence in some contexts, which reduces biases in decisions about risk. These effects of valence over- or under-sensitivity are predicted by prospect theory and the affect-as-information hypothesis. As these examples demonstrate, clinical researchers stand to benefit from applying theoretical approaches to emotion and cognition when studying decision making in psychiatric disorders.

Declarations of interest

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.01.048.

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