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Cognitive-behavioral therapy and decision science

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A B S T R A C T

In recent decades cognitive-behavioral therapy (CBT) and decision science (DS) have emerged within the field of psychological science. Though these are two vastly different areas of study, they are similar in that they address human information processing, cognition, behavior, and the link between them. In this article, we provide brief summaries of CBT and decision science, discuss their similarities and differences, and discuss how future research can identify ways in which these fields can inform each other. Several CBT techniques that might be of use to the efforts of the decision science field to prevent cognitive biases are suggested. Research that integrates these two fields may lead to the improvement of both.

1. Introduction

In recent decades cognitive-behavioral therapy (CBT) and decision science (DS) have emerged as important, though disparate, areas of psychological science. CBT is a form of psychotherapy that emphasizes the influence that cognitions, emotions, and behaviors have on each other. Decision science (also referred to as judgment and decision making, or JDM) is the study of normative, descriptive, and prescriptive theories of decisions in conditions of risk and uncertainty. While CBT is a technique by which to address mental health concerns and other problems of general well-being, decision science has been applied to fields such as medicine and economics. Though these are two vastly different areas of study, they are similar in that they are both focused on how cognitive processing affects outcomes. While we are not the first to discuss the commonalities between these fields (e.g., Baron, Baron, Barber, & Nolen-Hoekseman, 1990), the current literature still does not include empirical investigations about how advances in CBT and decision science might help each other.

Both fields have demonstrated that patterns of thought have developed that are not always effective and, at points, can become maladaptive and undesirable. Heuristics have developed as a means to make rough and ready decisions that are accurate most, but not all, of the time. They developed because they served us well more often than not, and are good rules of thumb. Within CBT, the idea of ineffective maladaptive cognitive processing emerges in the discussion of cognitive distortions, or the tendency to interpret ambiguous events in a negative way. Though some cognitive distortions may have emerged because they are helpful (e.g., dividing the world into black and white minimizes ambiguity and helps one to quickly categorize events and people), they can also extend into undesirable emotional reactions and even pathology (e.g., viewing oneself 100% negatively can lead to and perpetuate depression). So while heuristics and cognitive processing patterns have been learned because they are, for the most

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part, helpful in accurately simplifying and categorizing the world, they are not infallible. Both decision science and CBT have worked to correct irrational thinking by identifying information processing styles and patterns that can be inaccurate.

In this article, we provide brief summaries of CBT and decision science, discuss their similarities and differences, and suggest how these fields can inform each other. It is hoped that the discussion of the parallels between the fields will spark future discussions and empirical research that will cross over the two disciplines, improving both.

2. Cognitive-behavioral therapy

Cognitive-behavioral therapy is an empirically supported treatment for a host of mental health and wellness issues, such as depression, chronic pain, and insomnia. CBT is typically brief, collaborative, problem-focused, and goal-oriented. The theory behind the cognitive-behavioral approach is that both cognitive processes and emotional reactivity influence the development and persistence of mental illness and other problems, with the specific content of distressing thoughts varying by disorder. Cognitive processes are mood-congruent; for example, depression is characterized by cognitions related to failure or loss, whereas anxiety is depicted by thoughts of loss of control, danger, or death. Cognitive processes also differ between individuals; each individual has his own distinct thought patterns that are influenced by personal beliefs, schemas and past experiences. Cognitive-behavioral interventions focus on improving emotional reactivity, maladaptive behaviors and overall functioning by changing cognitions.

Cognitive-behavioral therapy is a treatment that resulted from the integration of behavioral therapy (e.g., Skinner, 1969; Wolpe, 1958, 1969) and cognitive therapy (Beck, 1976, p. 356; Ellis, 1969). Behavioral therapy views psychopathology as the result of conditioning with cognition playing no role in emotions or actions. To eliminate maladaptive behavior patterns, therapists use behavioral techniques to identify and alter environmental antecedents and outcomes that cause problems to persist. However, obsessive, ruminative cognitions and observational learning could not be addressed by behavioral methods alone. Data demonstrated that cognitive-behavioral techniques were either equivalent to or better than behavioral techniques for certain issues (Dobson & Dozois, 2001). For this reason, during the "cognitive revolution" of the 1970s, cognitive theorists (e.g., Beck, 1976, p. 356; Ellis, 1969) argued that changing individuals' cognitions is central to treating undesirable emotional reactions or disorders; still others posited that the fields be integrated for a cognitive-behavioral approach (Meichenbaum, 1977).

2.1. Cognitive distortions

Cognitive distortions contribute to individuals' misinterpretations of reality, over-attention to negative cues, or selective recall of negative situations, which contribute to negative schemas of the self, world and future (Taylor & Liberzon, 2007). These distortions influence emotional reactivity, and characterize emotional disorders, such as

Table 1
List of cognitive distortions.

Cognitive distortion	Description
All-or-nothing thinking (black-and-white thinking, polarized thinking)	Thinking in absolute terms, like "always" or "never."
Magnification	Distorting aspects of a memory or situation through magnifying or minimizing them such that they no longer correspond to objective reality – "make a mountain out of a molehill."
- Catastrophizing	*Catastrophizing* – Focusing on the worst possible outcome, however unlikely.
Minimization	Inappropriately viewing things as unimportant, such as one's desirable qualities.
Overgeneralization	Taking a single instance and making wide generalizations.
Control fallacies	*External Control Fallacy*: Viewing oneself as helpless because he or she is a victim of fate. *Internal Control Fallacy*: Viewing oneself as responsible for other's pain or happiness.
- External	
- Internal	
Blaming	Holding others responsible for our pain or misfortune.
Filtering	Focusing exclusively on negative aspects of an event while ignoring the positive.
Disqualifying the positive	Continually deemphasizing positive experiences.
Jumping to conclusions	Drawing conclusions from little or no evidence.
	Mind reading – Assuming knowledge of the intentions/thoughts of others.
- Mind reading	*Fortune telling* – Exaggerating how badly things will turn out before they happen.
- Fortune telling	
Labeling	Rather than describing the specific behavior, one assigns a global label to himself such as "I am a bad person."
- Mislabeling	Within this category is mislabeling, which is when one describes an event in an emotionally loaded way.
Should statements	Patterns of thought that imply the way things "should be" rather than the actual situation.
Emotional reasoning	Making decisions and arguments based on intuitions or personal feeling rather than an objective rationale and evidence.
Personalization	Attribution of personal responsibility/blame for events over which the person has no control.

depression (e.g., Dobson, 1989; Hamilton & Abramson, 1983; Hollon, DeRubeis, & Evans, 1996). Common cognitive distortions discussed within the CBT literature are listed in Table 1 (Burns, 1989).

2.2. CBT techniques

The techniques that are central to cognitive-behavioral therapies are goal setting, cognitive-behavioral assessment, self-monitoring, Socratic questioning, cognitive restructuring, problem solving, behavioral activation, relapse prevention, exposure and behavioral experiments. Each of these interventions is expected to influence cognitive processes, as well as emotional and behavioral reactions, which cognitive-behavioral theories view as intertwined. These interventions provide clients with an enduring set of skills that can be applied outside of therapy and even after the therapeutic relationship has been terminated, creating emotional resiliency. This aspect of a cognitive-behavioral approach empowers the client by encouraging him to make efforts at self-control and problem solving. It also contributes to the prevention of subsequent emotional vulnerability to lapses and relapse.

2.2.1. Goal setting

Initial goal setting establishes the client's expectations for treatment and highlights the possibility for change and emotional resilience. Conscious goals affect action (Ryan, 1970), direct attention toward goal-relevant behaviors, divert attention away from irrelevant ones (Locke & Bryan, 1969; Rothkopf & Billington, 1979), increase effort (Bandura & Cervone, 1983; Bryan & Locke, 1967), and increase persistence over time and in difficult contexts (LaPorte & Nath, 1976).

2.2.2. Cognitive-behavioral assessment

Ongoing evaluation of cognition, behavior, and emotion helps the client and therapist focus on treatment goals and assess client progress (Kirk, 1989). Assessment can include self-report, questionnaires, direct observation of behavior or behavioral byproducts.

2.2.3. Self-monitoring

The client objectively observes and records his symptoms, thoughts, behaviors and emotions outside of sessions. This helps evaluate the severity and frequency of problems, helps identify contingencies, highlights progress, and identifies triggers.

2.2.4. Cognitive restructuring

The client is instructed to view his thoughts as hypotheses, as opposed to facts. At times, the therapist will pose leading questions to introduce doubt about cognitions (Beck, Rush, Shaw, & Emery, 1979). This technique can highlight the attentional biases, selective recall, or negative interpretations of ambiguous events that contribute to undesirable emotional reactivity.

2.2.5. Problem solving

The therapist helps the client to identify struggles, brainstorm potential solutions, evaluate the likely effectiveness of solutions, and test the best ones. For ineffective solutions, the plan is modified or a new one is developed.

2.2.6. Exposure

Clients expose themselves to the stimulus that is associated with negative affect, to identify that the cues that have been avoided are not as fearful, painful, etc., as expected. This learning, based on counter-conditioning and extinction, establishes new contingencies on which subsequent emotional reactivity is based. This learning is then transferred, and during later encounters with the previously feared stimulus, the context should provide reminders of the newly acquired association between the feared stimulus and the more adaptive emotional and behavioral response.

2.2.7. Behavioral experiments

The client challenges the evidence for distressing cognitions by engaging in a particular situation to determine whether his negative thinking is true. For example, a client may be encouraged to buy new pants to evaluate whether the sales clerk comments on how "large" the pant size is. Again, this learning is then transferred such that later situations trigger more adaptive responses.

2.2.8. Relapse prevention

Clients identify their idiosyncratic high-risk or high-stress situations that may promote vulnerability to lapses, develop and practice coping skills to manage uncomfortable emotions, thoughts or sensations, and engage in pleasurable activities to promote mental hygiene.

Other techniques are listed in Tables 2 and 3 (Burns, 1989).

Table 2
Behavioral interventions used in CBT (Burns, 1989).

Behavioral interventions	Description
Target behavior	Identify behaviors client wants to change.
Exposure	Plan encounters with feared situations.
Exposure hierarchy	A list of increasingly feared stimuli/situations; the client will begin at the least feared and work through the list to the most feared.
Modeling and imitation	Therapist models desired behavior and client imitates it both in and outside of the session.
Behavioral activation	Schedule reinforcing activities (e.g., low-stress social events).
Rehearsal	Client practices the behaviors that he or she plans to engage in outside of therapy.
Progressive muscle relaxation	Clients are taught to relax their muscle groups, often while thinking of relaxing images.
Breathing retraining	Clients are taught to slowly breathe from the diaphragm.
Assertiveness training	Teach clients how to set and respect boundaries, defend themselves appropriately, and make requests respectfully.
Communication training	Clients are taught to actively listen, as well as use empathy, rephrasing, and I statements.
Reward	Client reinforces his behavior (e.g., self-praise, a special purchase, food).

Thus, the goal of CBT is to focus on current emotional reactivity, behavioral responses, cognitive processing style, and implement a process of questioning to identify and alter the client's idiosyncratic cognitions. Effective interventions improve psychological functioning by identifying these automatic thought patterns, as well as refuting and changing cognitions via cognitive and behavioral techniques. Over time, attentional, interpretational, and memory biases will decrease; one's ability to disprove negative thoughts will become stronger and the impact of thoughts will decrease over time. One of the crucial ways CBT does this is by teaching clients enduring skills that can be applied in a variety of scenarios, which help to reduce distress, increase resilience, and prevent vulnerability to relapse.

2.3. A brief discussion of CBT's empirical support

The efficacy of cognitive-behavioral therapy has been widely investigated and it is largely considered an effective treatment for a host of mental health and wellness concerns, most notably depression. For example, extensive research from the past four decades indicates that CBT is as effective as antidepressant medication during the acute phase of treatment (Dobson, 1989; Gloaguen, Cottraux, Cucherat, & Blackburn, 1998). Further, the benefits of CBT carryover even beyond the termination of therapy, whereas the gains from antidepressant medications do not persist after discontinuation (Blackburn, Eunson, & Bishop, 1986; Evans et al., 1992; Gloaguen et al., 1998; Kovacs, Rush, Beck, & Hollon, 1981; Simons, Murphy, Levine, & Wetzel, 1986). One study found that one-year relapse rates in CBT were approximately 30%, whereas relapse rates in those treated with medications were approximately 75% (Hollon et al., 2005).

In addition to depression, CBT has been shown to be effective in treating a host of anxiety disorders. In a study by Sharp et al. (1996), clients diagnosed with panic disorder and agoraphobia were treated with CBT (alone or in combination with medication). Those in the CBT condition were more likely to maintain gains six months after discontinuation than those in the medication-only group. In a similar population, Loerch et al. (1999) found that supplementing medication or placebo treatment with CBT enhanced treatment response. Further, clients in the medication- or placebo-only groups were more likely to seek further treatment after the study ended. Cognitive-behavioral techniques (e.g., prolonged exposure, stress-inoculation training, and cognitive reprocessing of the trauma) are demonstrated effective treatments been shown to be efficacious for post-traumatic disorder (PTSD; Cahill, Rothbaum, Resick, & Follette, 2009). Further, CBT has been shown to be effective in treating hypochondriasis (Barsky & Ahern, 2004; Clark et al., 1998; Warwick, Clark, Cobb, & Salkovskis, 1996), generalized anxiety disorder (Borkovec & Costello, 1993; Borkovec & Ruscio, 2001; Durham, Chambers, MacDonald, Power, & Major, 2003; Stanley et al., 2003), specific phobias (Ost, 1989), and insomnia (Babson et al., 2010; Pigeon, 2010). There is also support for CBT as an effective intervention for schizophrenia (Beck & Rector, 2000; Lehman et al., 2004; Tarrier, 2008; Wykes, Steel, Everitt, & Tarrier, 2008).

Table 3
Cognitive interventions used in CBT (Burns, 1989).

Cognitive interventions	Description
Identify upsetting thoughts	Everyone's automatic thought processes differ; identify which patterns are common for the client.
Rate level of agreement with thought and the degree of emotion associated with the thought	After identifying negative emotions, indicate which thoughts are associated with each feeling. Client rates on a 0–100 scale how sad/anxious/angry the thoughts make him, and how strongly he believes the thought.
Label the cognitive distortions	Give a name to the types of thought patterns on which the client typically relies.
So what!? (i.e., What would it mean if the thought were true?)	Have client explore consequences of if his negative thought were true. Example: Have him answer the questions, "If that is true, what would that mean? Why does that matter? What would happen?"
What is the underlying assumption?	Therapist and client explore underlying assumptions/rules. These are typically identifiable by "if-then" or "should" statements. E.g., "He should know why I'm upset."
Cost-benefit analysis	Discuss the advantages and disadvantages of feelings, thoughts or behaviors. What are you gaining from thinking/feeling/acting this way?
Worst case scenario	What will happen if the event occurs? What would be worse, better, or equivalent consequences? If the worst happens, how would you cope/problem solve?
Examine the evidence	For each distortion, thoroughly examine client's experience to identify the basis for negative thoughts.
Challenge the evidence and/or thought	Challenge the evidence by providing evidence contrary to the negative conclusion (e.g., "I have done poorly on a test before, and have still been able to catch up").
a. Think in shades of gray	Encourage client to accept the middle ground between two extremes (e.g., "I only completed half of my To-Do List today. I had some accomplishments, so I am not a complete failure").
b. Contemplate alternatives	Help a client find another conclusion for their evidence (e.g., "She did not say 'hello' to me. Instead of thinking she is angry with me maybe she did not see me").
c. Is it logical?	Do the client's conclusion follow logically?
d. Popular opinion	Have the client ask close friends/family whether their beliefs are accurate (e.g., "Would you be as anxious as I am about this situation?").
e. Examine definitions	What does a "loser" or a "failure" look like? What are their qualities? Does that really sound like you?
f. Double standards	"Would you apply the same standard to others? Why (why not)?"
g. Being proactive	Is there a problem that can be solved? Can the situation be improved? What are the goals, resources and behaviors required?
Acceptance	If there is nothing that can be changed, can the client accept reality?

Behavioral interventions based on exposure have been shown to be efficacious in treating social phobia, though gains are not generally well-maintained (DeRubeis & Crits-Christoph, 1998). Further, adjunctive cognitive restructuring may contribute to the maintenance of improvementss produced by exposure to social situations (Butler, Cullington, Munby, Amies, & Gelder, 1984; Heimberg, Salzman, Holt, & Blendell, 1993). Behavioral interventions including systematic desensitization and exposure plus response prevention are extremely effective and are the gold standards of specific phobia treatment (DeRubeis & Crits-Christoph, 1998). Similarly, exposure and response prevention is effective in treating obsessive-compulsive disorder (DeRubeis & Crits-Christoph, 1998).

In an effort to determine the crucial elements of CBT, dismantling studies have been conducted comparing cognitive and behavioral components, though these studies have largely been conducted in the context of depression. It has been shown that the behavioral ingredients of CBT were as effective as the cognitive components (Jacobson et al., 1996). Dimidjian et al. (2006) compared the cognitive and behavioral aspects of treatment along with antidepressant medication and only found differences in the subgroup of severely depressed clients. The efficacy of behavioral techniques were comparable to medication, and both were more effective than cognitive interventions. After one year, those who had been in either of the CBT conditions (behaviorally-focused or cognitively-focused) were less likely to relapse than those treated with medication and discontinued (Dobson et al., 2008). The authors concluded that behavioral interventions were as effective as medication and superior to cognitive components during the acute phase, but that CBT as a whole is more effective in preventing relapse to depression. A review found that behavior therapy alone was as effective as cognitive-behavioral therapy in treating adult depression and OCD (Butler, Chapman, Forman, & Beck, 2006). These and similar findings resulted in the emergence of an intervention called "behavioral activation," which minimizes the focus on the content of cognitions (Jacobson, Martell, & Dimidjian, 2001). Behavioral activation has been demonstrated to be as effective as medication among more severely depressed individuals, and outperformed cognitive therapy (Dimidjian et al., 2006).

An extensive review of meta-analyses (Butler et al., 2006) evaluated effect sizes for outcomes from CBT and other control groups. Large effect sizes were found for CBT in the treatment of adults diagnosed with unipolar depression, generalized anxiety disorder, panic disorder (with and without agoraphobia), social phobia, and PTSD. Moderate effect sizes were demonstrated for adults struggling with marital distress, anger and chronic pain. CBT appears to have enduring effects in treating depression, schizophrenia and many anxiety disorders. The long-term maintenance effects are one of the major advantages of CBT over medications.

3. Decision science

Decision science is a multi-disciplinary area of scholarship that focuses on the ways in which people make decisions in diverse settings. The theory of *bounded rationality* (Simon, 1955, 1956) states that there are limits (bounds) in human cognitive functions that prevent us from maximizing our chances for success. The term *satisfice* is used to describe the point at which people stop searching, or reach a cognitive bound (Simon, 1956). Decision scientists have developed a long list detailing the ways in which we are vulnerable to make errors in our decision making (e.g., availability bias, outcome bias, etc). *Prospect Theory* (Kahneman & Tversky, 1979) describes how people make judgments based on losses and gains rather than final outcomes. So while in many cases our mental shortcuts work in our favor, these mental heuristic shortcuts can yield mistaken consequences. Instead of considering endless options, we use *fast and frugal heuristics* to make decisions with a limited search for objects or cues (Gigerenzer, Todd, & the ABC Research Group, 1999).

Heuristics are simple, robust, and useful in a variety of environments (Gigerenzer & Brighton, 2009; Gigerenzer & Goldstein, 2002; Gigerenzer, Hertwig, & Pachur, 2011; Gigerenzer et al., 1999). The term "heuristic" refers to rough and ready ways of processing information. Heuristics are often helpful and make our decision making more efficient because using heuristics allows decision makers to spend less time searching for information by learning and then relying on the most useful information, less-is-more. Different situations call for different heuristics and therefore we have a variety of heuristics that we utilize (see Table 4). Our arsenal of heuristics can be compared to an adaptive toolbox:

> "Just as a mechanic will pull out specific wrenches, pliers, and gap gauges to maintain an engine rather than just hit everything with a hammer, different tasks require different specialized tools. The notion of a toolbox full of unique single-function devices lacks the beauty of Leibniz's dream of a single all-purpose inferential power tool. Instead, it evokes the abilities of a craftsman, who can provide serviceable solutions to almost any problem with just what is at hand." (Max Plank Bounded Rationality website).

The term "bias" typically implies a sort of prejudice or unfairness, such as gender bias or age bias. In the field of decision science, however, the term "bias" is used to describe errors in decisions that arise due to limitations of cognitive processing. Unlike heuristics, research on biases is focused mostly on the situations in which cognition is inefficient (and to some extent how to improve decision-

Table 4
Examples of heuristics.

Recognition heuristic	If one of two alternatives is recognized, infer that it has the higher value on the criterion
Take-the-best	To infer which of two alternatives has the higher value: (a) search through cues in order of validity, (b) stop search as soon as a cue discriminates, and (c) choose the alternative this cue favors.
Availability Heuristic	Probability of an event is estimated by the ease with which instances or occurrences can be brought to mind.

making in these situations). Biases are often explained using dual-process theory, which states that we have two cognitive systems, one that is fast and intuitive, and another that is slow and deliberate. Biases occur when our fast system operates without the oversight of the slow system.

The list of biases that have been investigated in the field of decision science is long; however there are many redundancies and overlapping themes among the biases. In order to identify trends of underlying themes of biases for discussion in this paper, we conducted an informal search and listed the biases and heuristics (120 were found). Reviewing biases by themes allows for a broad, yet succinct, introduction to the types of cognitive patterns that are investigated in decision science. The intent of this paper is not to comprehensively review these biases (for a review see Baron, 2000; Gilovich, Griffin, & Kahneman, 2002), but rather to provide a brief introduction to the broad range of biases and some of the underlying themes (see Table 5).

We identified four trends among cognitive biases and developed the following four groups based on the thought patterns: time, attention, paternalistic, and risk/loss. Some biases occur when a person's opinion or mindset was changed or distorted by the passage of time (Time category). For example, the hindsight bias is when a person exaggerates the chances that they would have reached a given conclusion when they have knowledge of the outcome of an event. Other biases occur when a person ignored relevant facts when making a decision (Ignore category). "Ignoring," as we conceive it, can be either willful or unconscious, but either way it leads people to omit important information when making a decision. Biases categorized into the Paternalistic biases category result from a stimulus outside of the control of an individual; the broadest of these is Anchoring. Anchoring is when a "starting point," or the information (stimuli, affect, etc.) that he/she is exposed to directly before making a decision directly affect that person's judgments. Finally, biases whose effect is to reduce risk/loss or to decrease acknowledgment of the possibility of loss were grouped into the Risk/Loss category. A straightforward example of this is Loss Aversion in which a person views possible losses as far more important than possible gains.

3.1. Preventing biases and heuristics

Attempts to prevent decision biases have yielded inconsistent and often disappointing results; many strategies have been found to be ineffective. Furthermore, prevention strategies are not generalizable to all biases or heuristics; a technique that helps minimize the reliance on one bias or heuristic does not necessarily mean it will work with another, or even with that same bias or heuristic in a different context. Nevertheless, some strategies have been successful in specific situations. Several publications have reviewed findings on decision debiasing (e.g., Larrick, 2008; Schwab, 2008).

Much of the extant literature has focused on the prevention of the *hindsight bias*. Findings suggest that the hindsight bias can be reduced by asking participants to think of possible alternative outcomes (Arkes, Faust, Guilmette, & Hart, 1988; Slovic & Fischhoff, 1977) and by providing participants with a written record of their cognitions, thoughts, and reasons generated in foresight (Davies, 1987). The strategy of increasing the decision maker's knowledge about various decision making biases and heuristics has yielded mixed results (Gambara & Leon, 2002; anchoring: Chapman & Johnson, 2002; Strack & Mussweiler, 1997; sunk costs: Bornstein, Emler, & Chapman, 1999). Similar to increasing knowledge about decision making biases, providing feedback to decision makers about their previous choices has been found to be

Table 5
Examples of cognitive biases.

Bias	Explanation/Example
Time category	
Hindsight bias	When decision makers with outcome knowledge exaggerate the chances that they would have predicted the outcome in advance.
Sunk cost fallacy	Persisting in a negative expected value activity because a significant investment has already been made.
Projection bias	Projecting onto the future not only affective states but any state that influences preferences.
Ignore category	
Omission bias	The tendency to choose not to do something when doing something might cause harm.
Attribution bias	Incorrectly determining who or what was responsible for an event or action.
Base rate neglect	Ignoring empirical statistics when making a probability judgment.
Confirmation bias	Seeking information that if consistent with the current hypothesis would yield positive feedback and to interpret evidence as consistent with the hypothesis.
Egocentric bias	Subjects will over report their contribution and underreport their group member's contribution.
Paternalistic category	
Anchoring	Different starting points yield different judgments which are biased toward the initial values.
Framing effects	Variations in framing information yield systematically different preferences.
Diversification bias	More variety is chosen when choices are bracketed together than when they were bracketed individually.
Unit bias	The tendency for people to eat less when serving sizes were smaller and more when serving sizes are larger.
Risk/loss category	
Ambiguity avoidance	People avoid gambles with an unknown distribution of possible outcomes.
Loss aversion	Losses loom larger than gains.
Regret avoidance	Averting a feeling that a decision will have an undesirable consequence.
Status quo bias	Preference to remain in the current state.
Risk aversion	Strongly favors the avoidance of risks.

a successful technique to adjust decisions made throughout time (e.g. Arkes, Christensen, Lai, & Blumer, 1987).

Incentives have been applied to increase motivation to improve decisions. However, results from studies about incentives are mixed (e.g. Camerer & Hogarth, 1999; Chapman & Johnson, 2002). Like incentives, accountability is used to increase motivation to improve decision making. By using accountability, decision makers are encouraged to anticipate social criticism with the expectation that this will motivate the decision maker to correct their judgment in order to prevent embarrassment. Assigning accountability for decisions has been successfully used as a strategy to prevent overconfidence bias on some prediction tasks; however this technique has not always been successful and may even exacerbate the bias (see Lerner & Tetlock, 1999 for a review). Problems with using accountability include increased reliance on salient (though not always appropriate) cues,and responses motivated by social desirability (Larrick, 2008).

One strategy that has been somewhat successful is the use of decision aids. A Cochrane Review (O'Connor et al., 2003) that examined the impact of decision aids on preference-sensitive decisions concluded that decision aids can improve patients' knowledge and help patients make decisions that are in line with their preferences. However, decision aids did not seem to impact decision satisfaction, anxiety, or health outcomes. More research will be needed to better understand the effectiveness of decision aids, and other debiasing methods.

4. A comparison of cognitive-behavioral therapy and decision science

CBT and DS can be compared on many levels (Table 6). Where the goal of CBT is to alter problematic thinking, the field of decision science primarily focuses on describing, not correcting, problematic thinking (or decision making). Where CBT therapists attempt to help the client to identify possible alternatives, decision science's focus is on choosing one of the alternatives. While this is a difference, the link between the identification and selection of options highlights a potential link between the two fields.

The cognitive patterns that DS and CBT have identified and labeled are their respective building blocks; however, there are numerous similarities between the patterns each field has identified, despite having arrived at different terminology. For example *filtering*, where an individual focuses solely on negative events and qualities that reaffirm his negative self-image, can be viewed as being related to the *confirmation bias*, where one looks for information to confirm pre-existing beliefs. Both cognitive patterns cause an individual to focus on only a portion of all available information, likely leading to inaccurate conclusions. Many of the cognitive distortions defined in CBT fit into the Ignore Category of biases: individuals who are focusing on limited information. The techniques used in the CBT and DS fields also have similarities. For example, labeling the cognitive distortions that one relies on is similar to the decision science method of improving individuals' knowledge of biases.

Table 6
Comparison of CBT and DS.

Cognitive behavioral therapy	Decision science
Founded in psychology	Founded in intersection between psychology & economics
Focused on pathological population	Focused on general population
Cognitive distortions	Cognitive biases and heuristics
Largely successful with improving	Often unable to be improved
Focus on changing problematic thinking	Focus on defining problematic thinking
Focuses on individuals	Focuses on trends among groups

A difference in the fields of CBT and decision making is in the context, the research and application. CBT is an applied field that incorporates the client's environment. CBT encourages the client to self-monitor, challenge, and modify their thoughts in their own environment, with the goal being for clients to generalize skills learned in the therapy room to real-life contexts. However, a majority of the work in decision science has been conducted in isolation from the context in which real-life decisions take place. While more work is being done in medical, legal, and other fields, there are still limitations to this research because numerous immeasurable variables are difficult to control for in applied research settings (e.g., previous experience, social influences). It is also unclear whether decisions made or skills used in the research setting would be utilized in the real-world.

Based on the parallels between biases and cognitive distortions, we suggest that CBT practitioners keep in mind various cognitive biases to supplement discussions of cognitive distortions. For example, Geir Kirkeboen of the University of Oslo suggests methods by which preventing biases can occur (Kirkeboen, 2009), several of which tap into CBT strategies. His suggestion of taking an outside view is similar to the CBT technique of challenging the evidence, such as asking others for their opinion (e.g., would you be as anxious as I am about this problem?) and also examining the evidence and probability that such an outcome is likely. Kirkeboen also encourages decision makers to "consider the opposite," which is aligned with CBT's nature of examining possible alternative explanations. Conversely, utilizing the techniques of cognitive-behavioral therapy in decision science may be beneficial; the implementation of the cognitive-behavioral techniques of goal setting, cognitive-behavioral assessment, self-monitoring, cognitive restructuring, exposure, behavioral experiments and relapse prevention may improve decision outcome.

4.1. Pioneering research

A few scholars have begun conducting research that integrates these two fields. Recently, Hertel and Mathews (2011) have highlighted the overlap of biases and emotional disorders in their discussion of Cognitive Bias Modification (CBM). CBM engages in the type of questioning we hope to encourage: developing and evaluating techniques for testing the conditions under which biases and cognitive processes exacerbate or mitigate emotional

symptoms in order to guide the creation of effective treatments.

Another recent example of the type of research that combines the ideas of biases, decision-making, and psychopathology is the work of Leykin et al. (Leykin & DeRubeis, 2010; Leykin, Roberts, & DeRubeis, 2011). Their research within the context of depression demonstrated that those with more depressive symptoms used fewer adaptive strategies to make decisions, made less productive decisions, and often chose an alternative that had failed in the past. They found that prompting depressed individuals to use adaptive decision strategies increased the productivity of decisions made. The decision science technique used in Leykin et al.'s work was similar to the process utilized in CBT, where therapists help guide the client's decision-making process by encouraging them to consider alternative possibilities, evaluate the evidence, and weigh the advantages and disadvantages of each solution. The therapist acts similar to a decision-making aid, slowing down the process to avoid the reliance on cognitive distortions, biases and ineffective strategies. The authors conclude that the teaching of decision-making techniques may be a productive use of therapy time for clients with depression.

Further, decision science can help motivate an individual through the stages of change (Prochaska & Velicer, 1997). Prochaska et al. identified six stages that a person goes through as he or she attempts to change behavior: precontemplation, contemplation, preparation, action, maintenance, and termination. They also highlighted the importance of decisional balance (Janis & Mann, 1977; Prochaska et al., 1994), or the individual's view of the pros and cons of engaging in behavior change (e.g., quitting smoking). Faculty of the Dartmouth Psychiatric Research Center utilized this combination of behavior modification and decision science in their creation of The Hazelden Co-Occurring Disorders Program (McGovern, Drake, Merrens, Mueser, & Brunette, 2008). In this treatment, the authors utilize payoff matrices to challenge harmful behaviors. By utilizing this decision science technique, the client is able to identify his or her perceived costs and benefits of maintaining current behavior (e.g., drug use), versus changing to more beneficial ones (e.g., abstinence).

4.2. Future directions

Given the overlap among these two independent fields, there are various ways in which they can inform, support, and build upon each other. The recent increased focus on client-centered care (AHRQ, 2002; Chewning & Sleath, 1996; Institute of Medicine, 2006) and the Recovery Model (Anthony, 1993; Anthony, Cohen, Farkas, & Gagne, 2002), which focuses on those suffering from mental illness being able to have an active role in treatment, living, and working decisions, makes future research on clients' ability to utilize effective decision strategies of significant import.

There are opportunities for the integration of CBT and DS. For example, decision science's broad list of cognitive biases provides insight into how the list of cognitive distortions might be expanded to better capture the cognitive processes of CBT patients. For example, it is likely that there are paternalistic factors affecting the thought processes of CBT clients, such as the way information is being framed or what sort of standards they hold as their "anchors." Therapists might give more consideration to paternalistic factors of patients' decision making in order to better help their patient change those thought patterns.

Several studies have found that people experiencing positive affect make optimistic judgments and choices, whereas those experiencing negative affect engage in pessimistic judgments and choices (e.g., Mayer, Gaschke, Braverman, & Evans, 1992; Mayer & Hanson, 1995; Schwarz & Clore, 1983). Psychiatric diagnoses may impair, or at least influence, decision making. For example, inability to think, concentrate, or make decisions is one of the DSM-IV's (APA, 1994) diagnostic criteria for a Major Depressive Episode. Further, those suffering from a manic state tend to engage in high risk behaviors (e.g., promiscuity, excessive spending). Given the link between mental illness and decision-making, cognitive-behavioral therapy can include decision science components to help individuals avoid making less than optimal decisions based on their mood state.

Those suffering from anxiety often struggle with the amount of unpredictability and risk that exists in the world. In fact, many experience emotional reactions that are disproportionate with their cognitive evaluations of risk of a certain situation (e.g., people with phobias of airplanes have significant anxiety despite the relative unlikelihood that they will be in a plane crash). Decision science techniques can be used to help a client realistically evaluate risk, which could reduce the intensity of their anxiety.

Anxiety and avoidance behaviors are prevalent in many psychiatric disorders. In addition to phobias, anxiety and avoidance characterize social phobia, post-traumatic stress disorder (PTSD), panic disorder, and agoraphobia. It is possible that by helping the client to understand that a certain level of risk exists in the world for everyone, their anxiety and desires to avoid or control risk may desist. Research should examine whether decision techniques focused on tolerance of risk are effective in reducing anxious cognitions and avoidance behaviors.

The behavioral technique of exposure – where one is presented with a situation that they have avoided, most likely due to anxiety – might be used to simulate the outcomes of various decisions in those who are indecisive, risk averse, or who have a history of poor decision outcomes. By exposing people – either imaginally, virtually, or in reality – to their feared outcome, they may realize that it is much more tolerable than anticipated, or that it even has some benefits (e.g., a poor decision provides for a learning opportunity). This may enable an avoidant or immobilized decision-maker to become comfortable with decision-making and its outcomes.

We would also contend that clinical psychology, CBT in particular, could encapsulate the use of all three types of models that Baron (2000) describes: normative, descriptive, and prescriptive. CBT could implement these models to provide a concrete, understandable framework by which a client could evaluate his or her behavioral decisions. Baron (2000) says that normative models can be described identifying the standard as the option that does the most

Table 7
Normative, descriptive, and prescriptive models applied to CBT.

Event	What happened? What is happening?
Normative model	What should I be doing? What behavior would lead to the most "good" or help me meet goals best?
Descriptive model	Is what I did or am doing in line with what I should be doing (i.e., the normative model standard that will meet my goals best)? Why aren't I acting according to the normative model determined earlier in therapy? What biases are keeping from doing what I should be doing?
Prescriptive model	How can I change my behavior to be in line with the normative model standard?

good, in this case best meets one's goals. CBT, then, could follow the format shown in Table 7.

Research could examine whether the payoff matrices used in Hazelden's co-occurring disorders are applicable to a wider range of mental illness and cognitions (e.g., phobias, anxiety). Additionally, a more thorough and detailed understanding of the mediating mechanisms and brain structures that are influenced by cognitive-behavioral interventions may help to apply findings in that field to decision science.

Finally, scientists could look to the work of Leykin et al. (2011) and Hertel and Mathews (2011) as examples of the fruitful possibilities of future research. Studies that determine how decision science can be incorporated into therapy for other psychiatric diagnoses, in various settings, or for those who have been deemed to lack the capacity to make their own treatment decisions are needed. Future research can also investigate whether aspects of CBT (e.g., focus on the context, interventions over time, individualized strategies, etc.) can be successfully applied to decision science to prevent biases and heuristics. Perhaps applying aspects of CBT techniques to decision making may be useful.

These are just several of many potential areas for further investigation of decision science and cognitive-behavioral therapy. The explicit integration and combination of the two fields is a unique idea, and it is hoped that this paper will spark interest that could result in improvements of therapeutic techniques and decision-making skills.

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