Thought Speed

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Thought Speed, Mood, and the Experience of Mental Motion

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ABSTRACT—This article presents a theoretical account relating thought speed to mood and psychological experience. Thought sequences that occur at a fast speed generally induce more positive affect than do those that occur slowly. Thought speed constitutes one aspect of “mental motion.” Another aspect involves thought variability, or the degree to which thoughts in a sequence either vary widely from or revolve closely around a theme. Thought sequences possessing more motion (occurring fast and varying widely) generally produce more positive affect than do sequences possessing little motion (occurring slowly and repetitively). When speed and variability oppose each other, such that one is low and the other is high, predictable psychological states also emerge. For example, whereas slow, repetitive thinking can prompt dejection, fast, repetitive thinking can prompt anxiety. This distinction is related to the fact that fast thinking involves greater actual and felt energy than slow thinking does. Effects of mental motion occur independent of the specific content of thought. Their consequences for mood and energy hold psychotherapeutic relevance.

Sometimes it's not what we are thinking about, but the speed at which we are thinking that is most noteworthy. After having one too many cups of coffee or when learning about an exciting new idea, we might feel our minds racing. In contrast, during a bout of writer's block or a brush with depression, we might feel our thoughts slowed to a halt. These alterations in thought speed may be accompanied by alterations in mood; for example, feelings of exhilaration may accompany moments of fast thinking. The account offered in this article provides one explanation for such relationships between mood and thought speed—it suggests that alterations in thought speed cause alterations in mood.

Thought speed can be viewed as one element of a more general concept of *mental motion*. Another element is thought variability, or the extent to which one's thought sequences end with propositions that either vary widely from or revolve closely around those with which they began. In this article, we provide a systematic account of the effects of thought speed and variability (collectively termed *mental motion*) on psychological experience. This account can be summarized by four main principles:

1. *The principle of thought speed.* Fast thinking, which involves many thoughts per unit time, generally produces positive affect. Slow thinking, which involves few thoughts per unit time, generally produces less positive affect. At the extremes of thought speed, racing thoughts can elicit feelings of mania, and sluggish thoughts can elicit feelings of depression.

2. *The principle of thought variability.* Varied thinking generally produces positive affect, whereas repetitive thinking generally produces negative affect. This principle is derived in part from the speed principle: when thoughts are repetitive, thought speed (thoughts per unit time) diminishes. At its extremes, repetitive thinking can elicit feelings of depression (or anxiety), and varied thinking can elicit feelings of mania (or reverie).

3. *The combination principle.* Fast, varied thinking prompts elation; slow, repetitive thinking prompts dejection. When speed and variability oppose each other, such that one is low and the other high, individuals' affective experience will depend on factors including which one of the two factors is more extreme. The psychological state elicited by such combinations can vary apart from its valence, as shown in Figure 1. For example, repetitive thinking can elicit feelings of anxiety rather than depression if that repetitive thinking is rapid. Notably, anxious states generally are more energetic than depressive states. Moreover, just as fast-moving physical objects possess more energy than do identical slower objects, fast thinking involves more energy (e.g., greater wakefulness, arousal, and feelings of energy) than does slow thinking.

4. *The content independence principle.* Effects of thought speed and variability are independent of the specific nature of thought content. Powerful affective states such as depression and anxiety have been traced to irrational and dysfunctional cognitions (e.g., Beck, 1976). According to the independence principle, effects of mental motion on mood do not require any particular type of thought content.

We now turn to evidence for these principles. After reviewing that evidence, we discuss relevant theoretical approaches, underpinnings of mental motion effects, applications to psychotherapy, and implications for future research. Throughout, we offer various illustrative examples, with a special focus on those involving mental disorders.

THE SPEED PRINCIPLE

We first review a range of evidence lending support to the hypothesis that thought speed positively affects mood. We then review experiments explicitly testing that hypothesis.

The Link Between Thought Speed and Mood

Mood Disorders

Mania is characterized by racing thoughts (*Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; *DSM-IV*; American Psychiatric Association, 1994; Miklowitz & Johnson, 2006). Patient descriptions are replete with references to fast thinking (in the sense of numerous thoughts per unit time). Consider this example from the prolific John Ruskin (Jamison, 1993, p. 29):

I roll on like a ball, with this exception, that contrary to the usual laws of motion I have no friction to contend with in my mind ... giddy with the quantity of things in my head—trains of thought beginning and branching to infinity.

Racing thoughts and the rapid speech that accompany them are displayed during most manic episodes (Goodwin & Jamison, 1990). That increased thought speed is associated with feelings of euphoria, as well as heightened energy, expansiveness, and inflated self-esteem (American Psychiatric Association, 1994; Miklowitz & Johnson, 2006).

Depression, the polar opposite of mania, has been described in terms of its crawling thought speed. Kraepelin (1921, p. 75) described the cognitions of depressed patients as “paralyzed” or “immobile,” and Wells (1922, p. 538) noted that “often absolutely nothing occurs to the patient.” Depression is also associated with a cognitive slowing, sometimes almost to the point that one’s thoughts seem to stop (e.g., Ianzito, Cadoret, & Pugh, 1974; Judd, Rapaport, Paulus, & Brown, 1994; Philipp, Maier, & Delmo, 1991). Depressed people often feel that their thoughts are so slow that they literally cannot think, and “diminished ability to think” is a criterial symptom of the disorder. In a major depressive episode, this slow thought speed is associated with subjective feelings of sadness, low energy, lack of pleasure in daily activities, and feelings of worthlessness (American Psychiatric Association, 1994).

Drugs

The effects of stimulant drugs demonstrate a link between thought speed and mood. Cocaine and amphetamines (“speed”) often bring about the experience of rapid or racing thoughts similar to that experienced in mania (e.g., Asghar, Tanay, Baker, Greenshaw, & Silverstone, 2003; Carey & Mandel, 1968; Chapel, 1973; Dackis & O’Brien, 2004; McTavish, McPherson, Sharp, & Cowen, 1999; Vollm et al., 2004). Also similar to mania, these drugs tend to engender feelings of euphoria, pleasure, increased energy, and decreased need for sleep (Asghar et al., 2003; Carey & Mandel, 1968; Cocores, Patel, Gold, & Pottash, 1987; Dackis & O’Brien, 2004; Murray, 1998; Stillman, Jones, Moore, Walker, & Welm, 1993).

One need not turn to illicit stimulants to experience a link between fast thinking and elevated mood. Aspects of cognition including reaction time, pattern recognition, and visual information processing are accelerated by both caffeine (Durlach, Edmunds, Howard, & Tipper, 2002; Smit & Rogers, 2000; Smith, Sutherland, & Christopher, 2005; Yoemans, Ripley, Davies, Rusted, & Rogers, 2000) and nicotine (e.g., Bates, Mangan, Stough, & Corballis, 1995; Edwards, Wesnes, Warburton, & Gale, 1985; Gentry, Hammersley, Hale, Nuwer, & Meliska, 2000; Warburton & Mancuso, 1998). Along with this increased speed of thought, it has also been suggested that increased energy and vigor and improved mood result from intake of caffeine (Judelson et al., 2005; Lieberman, 2000; Quinlan et al., 2000; Smit & Rogers, 2000) and nicotine (Gentry et al., 2000; Pomerleau & Pomerleau, 1992; Warburton & Mancuso, 1998; cf. Dar, Kaplan, Shaham, & Frenk, 2007).

Exercise

Watching professional athletes such as basketball players and bicycle racers suggests not only their enjoyment of the sport but also the lightning speed of their ability to mentally process and react to relevant stimuli. Also, studies have shown that exercise quickens psychomotor

speed, reaction time, and mental efficiency (Brisswalter, Collardeau, & Rene, 2002; Emery, Schein, Hauck, & MacIntyre, 1998; Lichtman & Poser, 1983; McMorris & Graydon, 1997; Yagi, Coburn, Estes, & Arruda, 1999), while improving mood and increasing energy (Hansen, Stevens, & Coast, 2001; Maraki et al., 2005; Osei-Tutu & Campagna, 2005; Rocheleau, Webster, Bryan, & Frazier, 2004).

Near-Death Experiences

In a rather esoteric area of investigation, Noyes and Kletti (1976, 1977) analyzed hundreds of accounts of people's near-death experiences. They found that people almost always spontaneously reported a quickening of their thought speed when they believed that they were on the verge of death. People expressed amazement at the number of thoughts or mental images passing through their minds in a matter of seconds. It was as if time itself stood still, leading them to have many more cognitions per unit of time than normal (Noyes & Kletti, 1976). In addition, despite the fact that these individuals' experiences were defined by the belief that they were on the brink of death, they often reported the surprising experience of feeling joyful and even euphoric. The experience was even described as comparable with a "morphine high" (Noyes & Kletti, 1977, p. 378).

Disorders of Movement

Although "movement disorders" in neurology refer to abnormalities of physical motion, a number of them affect mental motion as well. Parkinson's disease, which involves damage to dopaminergic neurons in the substantia nigra, profoundly interferes with physical motion (e.g., Gelb, Oliver, & Gilman, 1999; Ridenour & Dean, 1999). It also greatly slows thought speed (Hanes, Pantelis, Andrewes, & Chiu, 1996; Kutukcu, Marks, Goodin, & Aminoff, 1998; Ridenour & Dean, 1999). In neurological terms, the disease is characterized by both

bradykinesia and *bradyphrenia* (from Greek *bradus* “slow” + *kinesis* “motion” or *phrenos* “mind”). In his classic account of postencephalitic Parkinson’s patients, Sacks (1983, p. 16) wrote as follows:

Many patients, indeed, were... totally motionless for hours, days, weeks, or years on end... thoughts, appetites, and feelings, no less than movements—could also be brought to a virtual standstill.

It is noteworthy that the decreased thought speed that characterizes Parkinson’s is commonly accompanied by marked depression in mood and affect and even by major depressive disorder (Hanes et al., 1996; Ridenour & Dean, 1999).

Tourette’s syndrome is another movement disorder thought to involve abnormal activity of dopamine neurons (e.g., Albin & Mink, 2006; Yoon, Gause, Leckman, & Singer, 2007). It is characterized by motor tics that are fast, jerky, and repetitive (Lees, 1985; Osmon & Smerz, 2005; Robertson, 2006). Patients also show rapid thinking or *tachyphrenia* (from Greek *tachys* “swift”), manifested as quick, witty repartee and increased speed of reactions (Lees, 1985; Sacks, 1990). Tourettic patients’ thoughts and associations can be so rapid as to be hard to follow (Sacks, 1990). For example, Lees (1985, p. 63) described a patient with “new disconnected ideas constantly flooding into his mind.” When thoughts are in this sort of rapid motion, patients often appear giddy, elated, or excited (Sacks, 1989). Although Tourette’s can be debilitating, it is interesting that this experience of rapid thought can be associated with feelings of elation, excitement, and excess energy (Sacks, 1989).

Signs of a Causal Relationship

The above findings show a link between thought speed and positive affective experience. We now review evidence suggesting a causal relationship between these variables.

Musical Tempo

Listening to fast music necessitates faster mental processing than does listening to slow music. In addition, a number of studies have shown that the speed at which music is played affects the speed with which listeners complete cognitive tasks (Husain, Thompson, & Schellenberg, 2002; Nittono, Tsuda, Akai, & Nakajima, 2000). Research on the “Mozart effect,” for example, has shown an enhancement of spatial-temporal reasoning following exposure to a stimulating Mozart sonata, as well as music by other composers, including Bach and Schubert (for a review, see Rickard, Toukhsati, & Field, 2005). Researchers also have examined the consequences for mood and arousal of this more rapid tempo. People view fast music as “happy,” and listening to it enhances mood and arousal (Gagnon & Peretz, 2003; Husain et al., 2002; Kellaris & Kent, 1993; Thompson, Schellenberg, & Husain, 2001). Slow music, by contrast, induces negative mood (Clark, 1983).

Mania

Evidence from the temporal course of manic episodes also suggests effects of thought speed on mood. In particular, altered mood is not the first sign that a manic episode is coming. Rather, racing thoughts often occur before it. Racing thoughts are one of the most common *prodromes* (early medical signs) of a manic episode (Keitner et al., 1996; Lam & Wong, 2005; Molnar, Feeney, & Fava, 1988; Smith & Tarrier, 1992). Although other prodromes to mania have been documented, positive mood is not one of them. Apparently, elevated mood does not precede racing thoughts in mania, whereas racing thoughts often precede elevated mood.

Brainstorming

Group brainstorming is common practice in most business settings. During a brainstorming session, people are told to focus on “quantity and not quality” (Osborn, 1953; for a

review, see Nijstad & Stroebe, 2006). Thus, rapid thinking is a hallmark of the process. It is interesting that people engaged in group brainstorming do not generate especially good ideas (those working alone do better), but they enjoy themselves quite a bit (e.g., Nijstad, Stroebe, & Lodewijx, 1999, 2003; Stroebe, Diehl, & Abakoumkin, 1992). Experimental tests have demonstrated that people's speed of idea generation mediates the effects of group size on ratings of enjoyment. In one experiment, participants' speed of idea generation was experimentally manipulated by virtue of their being assigned to a group that brainstormed about an easy problem or a more difficult problem. People in the easy group not only generated ideas quicker but also reported a more joyful experience. Moreover, their positive affect was mediated by their faster speed of idea generation (Nijstad & Stroebe, 2006).

Direct Causal Evidence: “Manic Thinking”

These varied lines of research suggest that changes in thought speed elicit changes in mood. We now turn to experimental evidence testing this idea. In one experiment, conducted as part of a doctoral dissertation, Evdokas (1997) used the Rorschach inkblot test. The test was not used in its normal capacity as a diagnostic tool, but rather as an experimental manipulation. Participants were shown a series of inkblots and were asked to provide as many responses as they could without stopping. Those in a control condition also provided responses, but they were not given instructions as to the quantity or speed of their responding. Afterwards, participants completed a variety of measures, including one in which they indicated their current feelings on an “affect grid” (Russell, Weiss, & Mendelsohn, 1989). In comparison with control participants and with their own feelings at baseline, those led to respond quickly reported more positive affect. It is interesting that these effects did not occur in a fast condition that involved explicit time pressure.

Speed and Valence Experiment

Pronin and Wegner (2006) sought to test the specific hypothesis that fast thinking elevates mood, whereas slow thinking lowers it. Participants' thought speed was manipulated by inducing them to read at either a fast or slow speed. The fast speed was about twice as fast as their normal reading speed, and the slow speed was about twice as slow. The content that participants read grew either progressively more depressing or progressively more elating as they read 60 statements (Velten, 1968). Thus, the experiment manipulated thought speed and content in a fully crossed design: Speed (fast vs. slow) $\times$ Content (elating vs. depressing). After the reading task, participants completed measures of their perceived thought speed and of their psychological reactions including positive mood, which was assessed using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

The results (see Figure 2) showed the predicted effects of manipulated thought speed. Participants assigned to the conditions designed to induce fast thinking reported thinking faster than their peers in the conditions designed to induce slower thinking. Moreover, those in the fast-thought conditions reported more positive mood than did those in the slow-thought conditions. Because participants completed the PANAS mood scales both before and after reading, we also were able to examine changes in mood from baseline. These analyses (which were not conducted for the Pronin & Wegner, 2006, article, and thus are first reported here) showed that participants in the fast-thinking conditions felt significantly more positive mood after the manipulation than they did before it, $F(1, 72) = 10.18, p = .002$, and participants in the slow-thinking conditions felt significantly less positive mood after the manipulation than they did before it, $F(1, 70) = 12.09, p = .0009$. Participants who were induced to think fast also rated themselves as having more energy than did participants who thought at a slower speed, and they reported higher levels of

power, creativity, inspiration, and grandiosity. In short, participants' fast thinking seemed to have induced a sort of "mini manic" state. Perhaps the most striking finding of this experiment was that the effects of thought speed on mood were no less strong than the effects of thought content on mood (indeed, they were a bit stronger). There also was no Speed $\times$ Content interaction: Regardless of whether participants were led to think depressing or elating thoughts, they felt more positively when they had these thoughts at a faster speed.

Follow-Up Studies

Since this experiment, we have conducted a number of follow-up studies using different manipulations of thought speed. We have found that each of these manipulations induces positive mood, and the effect in each case is mediated by participants' reports of their thought speed. We describe three of these experiments below (and report others throughout the article when they are most relevant).

Self-Generated Ideas Experiment

Pronin, Jacobs, and Wegner (2008, Study 1) conducted an experiment examining whether the same effects of thought speed would occur when participants were induced to generate their own thoughts at a faster or slower rate. College students ($N = 79$) were given 10 min to jot down solutions to a novel problem (i.e., "how to make one year's [private] college tuition in a summer"). Those in the fast-thinking condition were told to generate "every idea that you possibly can." Those in the slow-thinking condition were told to generate "as many good ideas as you can." Afterwards, participants completed a questionnaire including measures of self-perceived thought speed, positive mood (i.e., on the PANAS), and energy.

The results were as predicted (see Figure 3). Although we did not manipulate thought speed directly, we found that participants in the fast-thinking condition generated significantly

more ideas per unit of time than did their peers and also perceived themselves as thinking faster. And, as predicted, they reported a more positive mood and higher levels of energy. Moreover, both their actual rate of idea generation and their self-perceived thought speed were predictive of positive mood, though both correlations were small ($r_s > .22$, $p_s < .05$). These effects could not be attributed to the participants feeling worse about the quality of their ideas in the slow-thinking condition nor could they be attributed to the ideas being of worse quality in the slow-thinking condition. This study suggests that the effects of thought speed observed by Pronin and Wegner (2006) occur even when individuals are left to generate their own fast thinking.

Stock Decisions Experiment

To explore whether the positive effects of thought speed would emerge for a different type of thought task, we conducted an experiment (Pronin & Ricci, 2007) in which participants ($N = 112$) made a series of rapid decisions. They were shown pairs of Fortune 500 companies (e.g., Exxon—Google, FedEx—JetBlue, Corning—Coach) on their computer monitor and asked to indicate which one was worth more money. In the fast-thinking condition, they had 4 s to think about and make each decision, and in the slow-thinking condition they had 35 s. They indicated their decisions via button press on a computer keyboard. After completing the decision-making task, they completed measures of self-perceived thought speed, positive mood, energy, and perceived decision quality.

When participants were induced to make faster decisions, they reported thinking faster ($M_s = 6.08$ vs. 5.38 , $SD_s = 1.58$ and 1.69 , $F(1, 110) = 5.24$, $p = .02$). They also reported more positive affect on the PANAS ($M_s = 4.05$ vs. 2.89 , $SD_s = 1.64$ and 1.45), $F(1, 110) = 15.63$, $p < .0001$, and more energy ($M_s = 3.59$ vs. 2.52 , $SD_s = 1.53$ and 1.15), $F(1, 110) = 17.30$, $p < .0001$. Moreover, the faster their reported thought speed, the more positive affect they reported ($r = .38$,

$p < .0001$). These effects were not due to any differences in decision quality: Participants' decisions were no better in the fast-thinking condition (participants made the correct decision on approximately 60% of the trials in both conditions), nor did they think their decisions were any better. This experiment suggests that positive effects of thought speed occur when thought speed is manipulated via rapid decision making.

“I Love Lucy” Experiment

To explore whether the observed effect of thought speed required the presentation of verbal stimuli, Pronin et al. (2008, Study 5) conducted an experiment using visual stimuli. Participants ($N = 73$) viewed a clip from the 1950s television situation comedy *I Love Lucy* (Arnaz, 1951), which was played without sound at either normal speed or fast speed (i.e., eight times normal speed).¹ Computer software was used to alter the speed of the episode while maintaining a smooth (i.e., not choppy or otherwise distorted) presentation. Participants narrated the clip as they watched. Afterwards, they reported their self-perceived thought speed and their mood.

Participants who watched the clip at fast speed perceived themselves as thinking faster than did those who watched the clip at normal speed ($M_s = 5.58$ vs. 4.12 , $SD_s = 1.82$ and 1.30), $F(1, 47) = 10.58$, $p = .002$. They also reported being in a more positive mood ($M_s = 2.43$ vs. 1.88 , $SD_s = 0.69$ and 0.63), $F(1, 47) = 8.53$, $p = .005$. Moreover, their self-perceived thought speed was predictive of that positive mood ($r = .39$, $p = .005$). This experiment demonstrates that effects of thought speed on psychological experience do not require the use of verbal stimuli for stimulating thought speed.

No one of these follow-up studies by itself provides definitive evidence that thought speed affects mood, as each one may have inadvertently manipulated some variable apart from

thought speed. Taken together, though, these studies suggest that effects of thought speed on mood can be induced by manipulations other than timed reading.

The Speed–Energy Link

Percolating through much of the findings discussed thus far is the suggestion of a relationship between thought speed and feelings of energy or arousal. In physics, speed and energy are directly related. A similar relationship seems to exist for mental motion. Fast thinking seems to be a “high energy” form of thought, and slow thinking seems to be a “low energy” form of thought. We now quickly turn to evidence, touched on in the above review, that fast thinking is associated with high levels of actual and felt energy and arousal and that slow thinking is associated with low levels of those responses. This relationship between thought speed and energy, we will later suggest, contributes to differences in psychological experience.

Some of the most popular drugs of abuse are stimulants such as amphetamines and cocaine. These drugs elevate metabolism, heart rate, mood, cognitive speed, motor speed, and subjective feelings of energy (e.g., Ashgar et al., 2003; Murray, 1998). More pedestrian stimulants such as caffeine and nicotine similarly affect not only mood but also arousal, heart rate, motor activity, wakefulness, and subjectively felt energy (e.g., Leiberman, 2000; Parrott & Winder, 1989; Quinlan et al., 2000). Thus, with each of these drugs, effects on mental speed are accompanied by effects on physiological signs of energy (e.g., metabolism, arousal) and subjective feelings of energy.

The symptoms of bipolar disorder also suggests this link. Mania is characterized not only by fast thinking and euphoria, but also by increased motor activity, rate of speech, wakefulness, and a decreased need for sleep (American Psychiatric Association, 1994; Goodwin & Jamison, 1990). By contrast, depression is characterized not only by slow thinking and dysphoria, but also

by decreased levels of physical activity, feelings of low energy, and a tendency to sleep more than normal (American Psychiatric Association, 1994).

Exercise provides another example of this thought speed–energy link. Exercise seems to be a drug-free intervention not only for improving mood, but also for quickening thought speed and increasing acute physical energy (e.g., elevating heart rate) and subjective feelings of energy (e.g., vigor, lack of fatigue), as well as long-term physical energy (e.g., increased metabolic efficiency). Indeed, studies have shown that even people suffering from clinical depression show positive effects of exercise on mood, felt levels of energy, and thought speed (Lichtman & Poser, 1983; Morgan, Roberts, & Feinerman, 1971). In a sense, exercise is a powerful antidepressant.

Experimental inductions of thought speed also have shown this speed–energy link. For three of the four previously reported experiments involving thought speed (i.e., the experiments involving speed and valence, self-generated ideas, and stock decisions), subjective feelings of energy were measured. All three experiments revealed the same result: Participants not only reported more positive mood after fast-thinking in comparison to slow-thinking, but also greater feelings of energy.

These findings suggest that fast thinking affects not only positive mood but also levels of actual and felt energy. We now turn to a discussion of another aspect of mental motion apart from thought speed: thought variability. After that discussion, we return to the speed–energy link and explore its role in the psychological experiences of fast versus slow variable thinking and fast versus slow repetitive thinking.

THE VARIABILITY PRINCIPLE

According to the variability principle, variability in thought generally enhances psychological experience, whereas repetition in thought generally harms it. The variability

principle in a sense derives from the speed principle. Fast thinking involves a large number of thoughts per unit of time. As a result, it might be logical to expect that when fast thinking is repetitious, its positive effects will be diminished. When one has the same thought over and over, even if it recurs at a rapid rate, one's thoughts are, in a sense, not moving.

Such looping thoughts are akin to the rotational motion of physical objects. Physical objects can rotate about their own axis (*spin*) like a disco ball. Or they can rotate about an external point (*revolve*) like a hamster running in circles on a caged wheel. The latter case involves some local variability, whereas the former is completely monotonous. Similarly, repetitive thinking can involve thinking the same thought over and over, or it can involve thinking a set of thoughts that are locally distinct but that center around a theme (e.g., "I am hungry. What is there to eat? I want a donut. What's for dinner?"). In both cases, thoughts are repetitive in that they rotate around a central proposition and ultimately "go nowhere."

We now offer evidence for this hypothesis from a variety of sources. Some of this evidence comes from cases similar to those reviewed in our discussion of thought speed, perhaps suggesting that the two elements of mental motion often co-occur in spontaneous (i.e., experimentally unmanipulated) thought. We conclude with an experiment that independently manipulates these elements and tests for the effects of each.

The Link Between Thought Variability and Mood

Mania

Mania generally involves varied thought. A common and criterial symptom of the illness involves "flight of ideas." During such thinking, thoughts "flit from one topic to another, usually with transitions based on arbitrary conceptual or verbal links" (Coleman, 2006, p. 288; also Sims, 2002). For example, when talking about a potential business deal to sell computers, a

manic salesperson may shift to discussing the history of the computer chip, the industrial revolution, or applied mathematics (American Psychiatric Association, 1994, p. 329). The link between flying ideas and positive affect has been described in a long history of phenomenological accounts, such as the intimate ones provided by John Cusance (1951) and Kay Jamison (1995).

Depression

In his classic account of the philosophy of William James, Eugene Taylor (1984) describes James' conception that thoughts that become "fixed" on a given idea (i.e., *idée fixe*) are a primary characteristic of mental illness, and of depression in particular. Depressive episodes are characterized not only by sad mood, but also by being mentally stuck or unable to have a naturally varying stream of consciousness (American Psychiatric Association, 1994; Wells, 1992). Depressive thinking repetitively loops to the same self-deflating thoughts (Beck & Young, 1985; Nolen-Hoeksema, 1991). Research has typically focused on the content of such ruminative thinking (e.g., Beck & Young, 1985; Goldberg, Wenzel, Welker, Steer, & Beck, 2005). However, rumination is also characterized by its style (Davis & Nolen-Hoeksema, 2000; Nolen-Hoeksema, 1991; Segerstrom, Stanton, Alden, & Shortridge, 2003). Ruminative thoughts are those that "revolve around a common instrumental theme and that recur in the absence of immediate environmental demands" (L.L. Martin & Tesser, 1996, p. 7). The ruminating individual is described as "trapped" in a looping cognitive process (Pyszczynski & Greenberg, 1987).

Anxiety

Repetitive thinking is also strongly implicated in anxiety disorders. Perhaps most notable in this regard is obsessive compulsive disorder (OCD). The thoughts experienced by people with

OCD are characterized by obsessions, or “persistent ideas, thoughts, impulses, or images” (American Psychiatric Association, 1994, p. 419). People with OCD often have a single thought or set of thoughts over and over. In a memoir of her adolescent experience with the disorder, Jennifer Traig (2004, p. 118) recalls as follows:

[F]or me the summer was defined by another blockbuster altogether. It was a rumination, a mental image that ran over and over in my head... images would start looping endlessly in my brain, [in] an unspooling reel.

Such continuously looping thoughts are experienced as unwanted and intrusive, and they are associated with marked anxiety and distress (American Psychiatric Association, 1994), subjective discomfort (Rachman, 1981), and deterioration in mood (Reynolds & Salkovskis, 1992).

Obsessive-compulsive thoughts often revolve around a few common themes, such as washing and checking, suggesting that it may be their content that makes them distressing. Without discounting that possibility, it is noteworthy that a number of studies suggest that the repetitive style of obsessive-compulsive thinking could contribute to its disturbing nature (for a review, see Clark & Rhyno, 2005). Patient reports (Rapoport, 1989; Traig, 2004) and research studies (Segerstrom, Tsao, Alden, & Craske, 2000), as well as the disorder’s diagnostic criteria (American Psychiatric Association, 1994), support the idea that the repetitive or continually looping nature of obsessive-compulsive thought is a key feature of the disorder.

Thoughts of a repetitive nature also characterize other anxiety disorders, including posttraumatic stress disorder (PTSD) and generalized anxiety disorder (GAD). PTSD is characterized by “persistent reexperiencing of [a] traumatic event” in the form of “recurrent and intrusive recollections or recurrent distressing dreams during which the event is replayed”

(American Psychiatric Association, 1994, p. 424). Worry, an essential feature of GAD, has been conceptualized as a thought process that is repetitive and uncontrollable (Roemer & Borkovec, 1993). As with obsessive-compulsive disorder, both of these disorders are accompanied by a marked degree of negative affect, irritability, and distress (American Psychiatric Association, 1994).

Creativity

The idea of thought variability versus repetition or “fixedness” is also suggested by research concerning creativity. Creative thinking is often described as involving a loose processing style of unusual associations among ideas (e.g., Runco, 2004; Vosburg, 1988). Boden (2004) explicitly refers to the importance of variability in the thought sequence, using the metaphor of physical motion:

M]aking—and also appreciating—the novel combination requires a rich store of knowledge in the person’s mind, and many different ways of *moving* around within it... Instead of exploring a structured geographical space, you explore a structured conceptual space.

The creative process has been conceptualized as involving the generation of many varied ideas in a short time, thereby allowing rapid associations among them (e.g., Osborn, 1953; Vosburg, 1988). Although past work has suggested that positive mood may promote creativity by facilitating loose cognitive associations (Isen, Daubman, & Nowicki, 1987; Isen, Johnson, Mertz, & Robinson, 1985), the other causal direction also is possible: varied or divergent thinking could contribute to the affective enjoyment that can characterize creative thinking. The opposite of this enjoyable experience characterizes every creative person’s nightmare—that is, some version of writer’s block. During such mental blocks, thoughts seem incapable of moving

in a particular direction and often feel stuck in a rut. In describing personal experiences with such blocks, the composer Gyorgy Kurtag referred to an occasional “compositional paralysis” (Flaherty, 2004, p. 94), and the psychoanalyst and painter Marion Milner (1950, p. 150) described an inability to surrender to the “rhythm” of the painting process. According to these accounts, the unpleasantness of the experience is at least in part related to the mental fixation of thoughts—one’s thoughts do not stop, but they fail to take a new direction.

Disorders of Movement

Neurological disorders of movement are characterized not only by extremes of mental (and physical) speed, but also by extremes of variability versus fixation in thought. The thoughts of Tourette patients often involve “loose, rapidly changing associations” (Sacks, 1989) and are characterized by “continually taking off on tangents” (Lees, 1985, p. 63). Notably, these mental experiences are often accompanied by glee and cheerfulness, despite the often unwelcome and aversive nature of the disease (Sacks, 1989). In contrast, Parkinson’s disease engenders extreme fixation of not only a physical, but also a mental, nature. The disorder has been described as affecting the ability to shift mental sets or change the course of thought (Cools, Van den Berken, Horstinek, Van Spaendonck, & Berger, 1984). As already noted, it is not unusual for depressive symptoms to accompany the disease (Hanes et al., 1996; Ridenour & Dean, 1999).

Positive Rumination

Finally, it is worth considering the interesting case of ruminating about positive thoughts. Initial research has begun to explore “positive rumination” and has suggested its causal effect on the manic experience (Feldman, Joormann, & Johnson, 2008). What is worthy of note with respect to our account, though, is that positive rumination may not be as cognitively repetitive as the term suggests. A good deal of past work has shown that although negative moods limit the

focus of cognitive content, positive moods do the opposite: they inhibit repetitive thinking and encourage varied and loose mental processing and a broadening of cognitive content (Fredrickson, 2001; Isen, 2000). Thus, although positive rumination may be highly repetitive in its affective tone, it may not be as repetitive in its content focus.

Signs of a Causal Relationship Between Variability and Mood

Mental Illness

Repetitive thinking during depression is not only a symptom of the illness but also a feature that perpetuates it and increases risk for it. Studies have shown that ruminative thinking lowers mood and predicts both the onset and persistence of depression (Mor & Winquist, 2002; Nolen-Hoeksema, 2000; Nolen-Hoeksema, Morrow, & Frederickson, 1993; Pyszczynski & Greenberg, 1987). In one study, a manipulation that reduced rumination made people subsequently less prone to depression (Gortner, Rude, & Pennebaker, 2006). In that study, depression-prone people who normally shied away from emotional expressiveness wrote about emotionally upsetting experiences. Subsequently, they were less likely to experience depression than were control subjects, and the effect was mediated by reductions in rumination. Although rumination is characterized by both its style (repetitive) and content (worry, self-deflation), and the effects of each have generally not been tested separately, researchers have suggested that the repetitive style of rumination may play a critical role in engendering and perpetuating depressive feelings (Nolen-Hoeksema, 1991; see also Segerstrom et al., 2000, 2003).

Repetitive thinking predicts the persistence of anxious symptoms (Segerstrom et al., 2000). Much of the literature on anxiety disorders, though, has stressed the uncontrollability of anxious cognitions rather than their repetitive nature as the main cause of negative affect (see Clark & Rhyno, 2005). The importance of a felt lack of cognitive control in producing anxious

experience does not detract from the assertion that repetitive thinking also contributes to negative affect in those illnesses. Indeed, the desire to control one's thoughts could result from the unpleasantness of their endlessly repetitive nature (Wegner, 1989). Studies have shown that attempts at thought control are highly correlated with the recurrent nature of those thoughts (Wegner & Zanakos, 1994). It is quite possible that the negative affect characteristic of anxiety derives from the repetitive nature of anxious thinking, as opposed to the content of that thinking or attempts to control it.

Novelty

In his classic studies, Berlyne (e.g., 1955, 1970) documented the tendency for humans and other animals to enjoy the experience of novel and varied stimuli. Exposure to novelty presents the mind with new cognitive stimuli to attend to (Berlyne, 1971). Berlyne's work suggests that this process of experiencing variety in the thought sequence is, in itself, pleasing, arousing, and rewarding. Berlyne (1970) found, for example, that varied cognitive stimuli produce more pleasure than do uniform stimuli. More recent work in neuroscience has provided additional support for Berlyne's findings. Studies have shown that exposure to cognitive stimuli that are varied or novel, rather than repetitive or familiar, induces chemical changes in the brain that resemble those produced by pharmacological "highs" in terms of their effects on mesolimbic dopaminergic activity (e.g., Bardo, Donohew, & Harrington, 1996; Rebec, Christensen, Guerra, & Bardo, 1997; Suhara et al., 2001).

Brainstorming

One reason why people enjoy group brainstorming—despite its weaknesses as a strategy (e.g., Mullen, Johnson, & Salas, 1991)—seems to be that the process involves exposure to a large and varied number of ideas. In a meta-analysis of six studies, Nijstad and Stroebe (2006)

found that when people become “stuck” during brainstorming sessions (i.e., when they do not generate any ideas or when those that they do generate are simply repeats of old ideas), they experience decreased enjoyment. When people brainstorm in groups rather than as individuals, they are less likely to get stuck, and this seems to account for the differences in enjoyment between individual and group brainstorming (Nijstad & Stroebe, 2006).

Direct Causal Evidence: Variable Thinking Versus Repetitive Thinking

The foregoing review suggests that people will report more positive affect when induced to experience varying thoughts as opposed to repetitive ones. We now present an experiment designed to test that hypothesis.

Variability and Speed Experiment

To examine effects of thought speed and variability on mood, we assigned 74 participants to one of four conditions in a 2×2 (Speed $\times$ Variability) design. Participants read neutral-content statements presented to them on a computer monitor at a timed pace that was either faster or slower than normal reading speed (see Pronin & Wegner, 2006). In the variable condition, participants read 63 different statements (e.g., “A pilot light remains continually lit in a gas stove.”, “In ring toss, players throw a loop over a peg.”, “There is no twelve of diamonds in a deck of cards.”). In the repetitive condition, they read 3 different statements, each presented a total of 21 times in a randomized order. Five different versions of the repetitive condition were used, with a different trio of statements (of equal length) for each one, to ensure that differences in content were not a key independent variable. All statements used in the experiment were selected based on five raters’ assessments of their affective neutrality (on a 7-point positive–negative scale, each item fell within a half-point of the neutral midpoint; the mean neutrality rating of the 63-item set was 3.96, and the mean neutrality rating for each of the five 3-item sets

was 4.00).

After reading the statements, participants filled out a grid in which they were asked to place an “X” indicating where they fell, at that moment, on a two-dimensional grid of mood and energy (e.g., Russell et al., 1989). Responses were coded as coordinates (millimeters of deviation in the positive or negative direction) from the central point (or origin) of the axes. Participants also completed the PANAS mood measure.²

The results were consistent with our theorizing. Main effects on mood emerged for thought variability as well as for thought speed. Participants reported more positive mood on the affect grid in the variable conditions than in the repetitive conditions ($M_s = +14.76$ vs. $+4.06$, $SD_s = 14.44$ and 20.11), $F(1, 71) = 8.97$, $p = .004$, and they also reported more positive mood in the fast conditions than in the slow conditions ($M_s = +15.02$ vs. $+3.78$, $SD_s = 14.42$ and 19.97), $F(1, 71) = 9.83$, $p = .003$. Similar results appeared on participants’ responses to the PANAS mood measure: Participants reported more positive affect on the PANAS after being induced to think variably rather than repetitively and also after being induced to think fast rather than slow (both $F_s > 7$, $p_s < .01$). There was no interaction between the two variables on either measure (the affect grid or the PANAS). Overall, participants felt more positive affect not only when they were led to think fast rather than slow, but also when they were led to have varied thoughts as opposed to repetitive or continuously looping thoughts.

We also measured participants’ felt levels of energy. Consistent with our theorizing about a speed–energy link, participants reported significantly more energy in the fast-thought conditions than they did in the slow-thought conditions ($M_s = +11.34$ vs. -11.28 , $SD_s = 19.88$ and 19.73), $F(1, 71) = 25.44$, $p < .0001$; energy did not differ as much based on variability ($M_s = +4.42$ vs. -3.97 , $SD_s = 23.09$ and 21.83), $F(1, 71) = 3.43$, $p = .07$.

Taken together, these results support the notions that thought speed and variability both affect mood in a positive way and that thought speed is also associated with feelings of heightened energy.

THE COMBINATION PRINCIPLE

The evidence presented thus far suggests that both thought speed and variability affect mood. But what happens when these two aspects of mental motion combine? We suggest that thought speed and variability each exert positive effects but that different psychological states emerge when the two combine in opposition to each other (e.g., when thoughts are high in speed but low in variability) than when they combine in cooperation with each other (e.g. when thoughts are high in both speed and variability). Figure 1 presents an illustrative depiction of the psychological experiences associated with these various combinations.

Fast Speed, Low Variability Thought

In physics, an object that rapidly races over a stretch of physical distance possesses more energy than an object that slowly inches along that same path. The same is true of objects that spin around in the same place (such as disco balls or windmills). Although these objects are characterized by motion that is repetitive rather than varied, they nevertheless possess energy corresponding to their speed. Something similar seems to be true for thoughts. Thoughts that repeat themselves at a fast rate seem to be associated with more energy than are thoughts that repeat themselves at a slow rate. This concept helps us to distinguish between two different forms of thinking that both involve repetition: forms that are fast, and forms that are slow.

Anxiety Versus Depression

Repetitive thoughts are linked with negative affect in both anxiety and depression (e.g., Nolen-Hoeksema, 2000). The precise nature of those psychological states, however, is not the

same. At the extremes of these two sorts of feelings (i.e., cases of clinical depression and anxiety), the two states are often comorbid (American Psychiatric Association, 1994), and, more generally, the experience of different forms of negative affect (including anxiety and depression) tend to correlate highly with each other (Diener & Iran-Nejad, 1986). Yet feelings of anxiety versus depression, and the mental illnesses that occur at their extremes, have a number of characteristics that make them distinct. Individuals experiencing depression often describe their mood as dejected, sad, hopeless, discouraged, or “down in the dumps.” Some people complain of feeling “blah,” and decreased energy, tiredness, and fatigue are common (American Psychiatric Association, 1994). In anxiety, however, the mood effects involve a much greater degree of physiological arousal, most notably irritability, distress, worry, apprehension, and fear. Restlessness, feeling “keyed up,” and being unable to sleep are common (American Psychiatric Association, 1994). Laboratory findings have shown increased autonomic activity in anxiety disorders including PTSD, OCD, GAD, and panic disorder (American Psychiatric Association, 1994).

How can we account for these differences? Theorists have suggested that thought content is what implicates thoughts in depression as opposed to anxiety or vice versa (e.g., Beck, Brown, Steer, Eidelson, & Riskind, 1987; Clark, Beck, & Brown, 1989; Kendall & Ingram, 1989). Our account of mental motion suggests that another factor could be the speed at which repetitive thoughts occur in each disorder.

Cognitive slowing is a hallmark symptom of depression. Whereas depressed thoughts often occur slowly, anxious thoughts often occur rapidly. Although both nonclinically and clinically anxious people have thoughts of worry or obsession, what distinguishes those with a diagnosable disorder from the rest is the rate (or speed) of these thoughts (Purdon & Clark,

1994). In the case of OCD, the severity of anxious symptoms is a positive function of the frequency per unit of time of obsessive thoughts (Spinella, 2005).

The results of one study suggest that the speed of repetitive thoughts differentiates the experience of depression from that of anxiety (Giambra, Grodsky, Belongie, & Rosenberg, 1994). The researchers examined the rate of depressed patients' unintentional thoughts during performance of a vigilance task. Participants with more depressive symptoms showed slower rates of intrusive thoughts during the task, whereas participants with more anxious symptoms showed faster rates of intrusive thoughts. In short, a critical difference between repetitive thoughts that characterize anxiety versus those that characterize depression seems to be the speed of those thoughts.

A Direct Test

To provide a specific test of this hypothesis, we conducted an experiment (described earlier in the context of thought variability) allowing us to compare the psychological experiences of fast repetitive thinking and slow repetitive thinking. In addition to reporting on their felt mood and energy, participants responded to measures assessing their feelings of anxiety and depression. These measures included items concerning feeling states indicative of anxiety (e.g., anxious, nervous) and depression (e.g., depressed, gloomy) and also desires to engage in behaviors consistent with anxiety (e.g., pacing, checking) and depression (e.g., sleeping, listening to sad music).

Our primary prediction involved a statistical interaction. We expected that participants' feelings of anxiety or depression would depend on whether their repetitive thoughts were fast or slow. This prediction was supported, $F(1, 34) = 18.34, p < .0001$. As shown in Figure 4, participants who had been led to think slowly and repetitively reported feeling more depressed

than anxious, $F(1, 34) = 12.41, p = .003$, whereas those who had been led to think fast and repetitively reported feeling more anxious than depressed, $F(1, 34) = 8.23, p = .01$. Apparently, fast and slow repetitive thoughts led to different psychological experiences of negative affect, with the former involving more anxiety and the latter involving more dysphoria.

We also examined a secondary prediction consistent with our mental motion account. That is, we tested whether differences in participants' felt energy were correlated with these differences in feelings of anxiety and depression. As predicted, our manipulation of the speed of participants' repetitive thinking predicted their levels of felt energy ($M_s = +8.26$ vs. -17.65 , $SD_s = 20.70$ and 13.58), $\beta = .60, t(34) = 4.38, p = .0001$. Moreover, higher levels of reported energy following our experimental manipulations predicted greater feelings of anxiety rather than depression (calculated as a difference score), $r(34) = .58, p = .0002$. This result suggests that the energy component of thought speed may be related to the distinctive psychological experiences associated with slow and fast repetitive thoughts.

Slow Speed, High Variability Thought

The preceding experiment and discussion make clear that fast (or high energy) thoughts do not always induce positive mood. An exception involves thoughts that are fast but that “go nowhere.” Like a lost motorist speeding around in circles, such thoughts may feel more frustrating and anxiety-provoking than joyous and exhilarating. But what of the reverse case—thoughts that lack speed but that are not repetitive? Such thoughts are like a feather floating through the air—they are going somewhere, but not fast. If fast repetitive thoughts produce high-energy negative affect, then slow variable thoughts might be expected to produce low-energy positive affect. Some examples consistent with that expectation are reviewed below. It is also worth noting, though, that other examples might occur (such as low-energy mildly negative

affect), depending on the exact context and the balance of speed versus variability involved.

Meditation

Slow but varied thinking characterizes one type of meditation, known as “mindfulness meditation.” Its practice involves allowing thoughts to float by, shifting from one to another in an open “cognitive field” (Cahn & Polich, 2006, p. 181; also Jain et al., 2007). This process affords a large degree of variability in that thoughts continually change throughout the process. Mindfulness meditation also induces slower thinking; it has been likened to a “slowing of the mind’s internal dialogue” (Jain et al., 2007; also Leary, 2004). Experimental evidence has found mental processes to be slower among individuals engaging in it (Brown, Forte, Rich, & Epstein, 1982).

The experience of mindfulness meditation also results in a positive affective reaction and in activation of brain areas associated with positive affect (Davidson et al., 2003). The psychological state that accompanies mindfulness meditation, however, is of course different from that of mania. It induces a deep sense of calm, peacefulness, relaxation, and contentedness (Jain et al., 2007), as well as a decrease in arousal so great that the state is related to drowsiness, sleep, and being unconscious (Austin, 1998; Vaitl et al., 2005). This more low-energy state of positive affect is consistent with the fact that mindfulness meditation involves thoughts that vary slowly. Mindfulness meditation has been found to reduce feelings of anxiety and stress (e.g., Eppley, Abrams, & Shear, 1989; Grossman, Niemann, Schmidt, & Walach, 2004; Kabat-Zinn et al., 1992; Speca, Carlson, Goodey, & Angen, 2000), which is consistent with our suggestion that slow variable thinking is the direct opposite of the sort of thinking that promotes anxiety (i.e., fast repetitive thinking). In addition to its potential to boost positive affect, meditation also seems able to alleviate negative affect.

Concentrative meditation also poses an interesting case for consideration. Concentrative meditation involves focusing on something specific such as one's breath or a mantra—thus, it retains some elements of repetitive thinking. It is worth pointing out, however, that even in such cases the meditator's thoughts remain variable in the sense that he or she allows other thoughts and sensations to arise and to pass without clinging to them (Cahn & Polich, 2006). Our theorizing suggests that even efforts at concentrative meditation may alleviate feelings of anxiety by relieving the experience of rapid repetitive thought. Nevertheless, it is notable that reviews of the literature have generally focused on the positive effects of mindfulness meditation more than those resulting from concentrative meditation.

Depressants

Some drugs may offer a similar, albeit more artificial, way of obtaining the low energy form of thought obtained via meditation. The term *depressant* does not sound like a great advertisement for a recreational drug. Nevertheless, such drugs are popular candidates for abuse, whether obtained on the street, from the medicine cabinet (e.g., benzodiazepines such as Valium or Xanax), or from a drink at the local bar. The popularity of these drugs suggests that they offer some benefits to the user. Those benefits may include reduced behavioral inhibition of the sort induced by drinking alcohol (Fillmore, Vogel-Sprott, & Gavrilescu, 1999). Some of those benefits also may accrue from the dose-dependent effects of depressants, which paradoxically behave like stimulants when taken in low doses (F.H. Martin & Siddle, 2003). It is also possible that increased doses alter mental motion in a way that produces a pleasant affective state, though this is a matter for future research. Indeed, although depressant drugs decrease physiological arousal, felt levels of energy, and cognitive speed (see Fagan, Scott, Mitchell, & Tiplady, 1991; F.H. Martin & Siddle, 2003; Stewart, 2005; Tzambazis & Stough, 2000), they have not been

shown to inhibit positive mood and can produce feelings of peaceful relaxation. Part of the reason for this may be that these drugs slow thinking down without making it repetitive. They may elicit thoughts that better resemble a floating feather than a disco ball with a drained battery. Depressants are often used as anxiolytic (antianxiety) drugs, perhaps because they can induce thinking that is slow and varied rather than rapid and repetitive.

Attention Deficit Disorder

The *DSM-IV* (1994) distinguishes between attention deficit disorders that primarily involve low attention and those that primarily involve hyperactivity or impulsivity. A recent review supported this distinction (Milich, Balentine, & Lynam, 2001). The primarily inattentive form, formerly termed ADD, characterizes cognition and behavior that appears “spacey,” “foggy,” and “daydreamy.” Until the most recent edition of the *DSM* (1994), “sluggish cognitive tempo” was listed as a symptom of this illness. Researchers have argued that, based on the existing evidence, sluggish cognitive tempo (i.e., slow thinking) is a characteristic of ADD that differentiates it from the hyperactive form (Hartman, Wilcutt, Rhee, & Pennington, 2004; McBurnett, Pfiffner, & Frick, 2001). Thus, ADD seems to be another case of slow-moving variable thinking. Notably, despite the obviously disruptive effects of the disorder, negative affect is not diagnostic of it.

THE CONTENT INDEPENDENCE PRINCIPLE

We have proposed that effects of mental motion occur independently of thought content. In its simplest form, the content independence principle means that thought speed and variability impact mood apart from the content of one’s thoughts. For example, one need not think “happy thoughts” in order to feel better if one’s thoughts are fast rather than slow. Thoughts that are fast will generally improve one’s mood more than thoughts that are slow, and thoughts that are

repetitive (i.e., in terms of focus) will generally make one feel worse than will thoughts that are varied. This does not mean that thought content does not affect mood. For example, much research and theory has explored the role of irrational and dysfunctional thought content in the origins of mental illness—especially depression and anxiety (e.g., Abramson, Metalsky, & Alloy, 1989; Beck, 1976; Ellis, 1962; c.f. Johnson-Laird, Mancini, & Gangemi, 2006). Rather, this principle suggests that mental motion is a separate cause of mood that can exert its effects across varying types of thought content.

One potential alternative to the independence principle is that thought speed and variability are naturally confounded with thought content. This confound account would argue that the observed effects of speed and variability reflect a tendency for variable and fast thinking to occur when thoughts are positive in content (and, the critique would imply, it is the content of fast and variable thinking rather than its form that induces the relevant affect). Indeed, studies have shown that positive emotion can induce mental motion in the sense of broad thinking and loose associations, suggesting that the path from mental motion to positive mood may also go in the opposite direction (i.e., from positive mood to mental motion) or may go in both directions (Fredrickson, 2001; Isen, 2000; Isen et al., 1985).

Another potential alternative to the independence principle, the matching account, states that thought speed and variability only exert their effects when thought content matches thought speed or variability in its effects. This critique might argue, for example, that fast thinking (or variable thinking) only induces positive affect when the content of thoughts is positive; or, it might offer a “mismatch” argument whereby, for example, fast thinking only induces positive affect when the content of thoughts is negative. Such a mismatch account has some intuitive appeal. It is easy to imagine, for example, that it is better to have negative thoughts quickly or

that it is better to spend time dwelling on positive thoughts.

Finally, a third potential alternative might be an amplification account, whereby fast speed (and variability) amplify the feelings associated with whatever content people are experiencing, such that happy thoughts lead to yet more elation when they are fast and variable, and sad thoughts lead to yet more depression when they are fast and variable (or perhaps slow and repetitive thinking, rather than fast, variable thinking, has this amplifying effect).

A response to these alternatives rests on the evidence. That evidence, reviewed below, speaks against these alternatives and supports the content independence principle.

1. Effects of mental motion have been documented in cases where thought content does not differ with speed or variability. In those cases, content is, in essence, controlled. This rules out several of the possibilities raised by the various accounts described above. It rules out the suggestion that mental motion (speed and variability) differences must be confounded with content differences to elicit the observed effects (e.g., fast thoughts must also be of happy content). It also argues against the matching account by showing that mental motion need not match (or mismatch) thought content to produce its effects.

This point has been illustrated in numerous experiments in which participants were induced to think about the same content, regardless of experimental condition. For example, in our stock decisions experiment (described earlier), participants experienced more positive mood after thinking fast than they did when thinking slowly about precisely the same decisions. And in our *I Love Lucy* experiment (described earlier), participants experienced more positive mood after watching the same silently displayed television program at a fast speed rather than a normal speed. Research on group brainstorming also supports the idea that variability in thought feels better than repetition, even when both types of thinking involve the same type of content (Nijstad

& Stroebe, 2006).

2. Effects of mental motion have been documented in cases where thought content is neutral. Much like cases in which thought content is controlled, cases in which thought content is neutral demonstrate that thought content need not be valenced in a particular way to produce effects of mental motion. Thus, these cases argue against the matching account. They also argue against the confound account, as they experimentally remove any confound between mental motion and content. Finally, they argue against the amplification account, as they show that fast speed and variability increase positive affect when thoughts are neutral, whereas the amplification account implies that thoughts must have some initial valence (positive or negative) that would then be amplified by fast or varied thinking.

The relevant evidence shows that thoughts (even those of neutral content) produce more positive affect when they occur in rapid rather than slow sequences and when they are varied rather than repetitive. In our variability and speed experiment (described earlier), we pretested statements to find those with neutral content (e.g., “In ring toss, players throw a loop over a peg.”). Participants reported more positive mood after reading neutral statements quickly rather than slowly and after reading those that varied rather than those that were repetitive (even when the repetitive ones were pretested to ensure that they possessed the same level of neutrality as the variable ones).

3. Effects of mental motion have been documented in cases in which that motion is induced by factors not believed to impact thought content. Mood effects of thought speed and variability in reaction to manipulations that are not thought to perturb thought content further support the independence principle.

Examples of such cases include pharmacological substances that alter thought speed by

interfering with basic neurochemistry (e.g., amphetamines, caffeine) and neurological disorders of movement that affect thought speed and variability (e.g., Parkinson's disease, Tourette's syndrome), each of which have already been described in detail. Another previously discussed example is that of listening to fast or slow music. Past research suggests that the effects of music speed on mood are not due to any content-based confounding features of the music (e.g., lyrics, melody) but are instead due to the actual tempo (or speed) of the music itself (e.g., Johnson-Laird & Oatley, 2000).

4. The independence principle has received direct support from an experiment independently manipulating thought speed and content. That experiment (Pronin & Wegner, 2006) addresses each of the alternatives to the independence principle by (a) unconfounding thought content and speed, (b) testing all possible matches and mismatches of speed and content, and (c) including the conditions necessary to test the amplification hypothesis.

The Pronin and Wegner (2006) speed and valence experiment (described earlier) used a 2×2 design: Thought Content (positive vs. negative) $\times$ Thought Speed (fast vs. slow). To provide a powerful content manipulation, Pronin and Wegner used the Velten (1968) procedure, which consists of a series of statements that become increasingly elated or depressed (depending on condition). Early in the elating content conditions, participants read "I do feel pretty good today"; early in the depressing content conditions, they read "I feel a little low today." The elating conditions ended with "Wow! I feel great!", and the depressing conditions ended with "I want to go to sleep and never wake up." These statements were explicitly designed to induce a depressed or elated mood by reading them (and have been well-established to have that effect; for reviews, see Kenealy, 1986; Larsen & Sinnett, 1991).

The key result of this experiment was that participants experienced a more positive mood

when they were induced to think fast than they did when they were induced to think slowly, and simple effects tests revealed that those effects were significant for both participants led to think elated thoughts and those led to think depressing thoughts. There was also no interaction effect of thought content and thought speed. Participants felt happier when they thought quickly both when their thought content matched and when it mismatched their thought speed. The well-established Velten procedure exerted its usual effects on mood, but not to any larger a degree than the effects of thought speed (and perhaps even to a smaller degree). Moreover, thought speed did not amplify the Velten effect; it instead produced an independent effect.

Taken together, the evidence for the independence principle is strong. However, a few caveats are worth noting. Existing evidence does not rule out the possibility of as-yet undiscovered interactions between thought content and mental motion. For example, extremes of thought content may prevent mental motion effects from occurring. In this regard, we do not claim that mental motion is a panacea for displeasing thought content. Nor do we claim that the lack of it is a weapon that can destroy the positive effects of pleasing thought content. Even when one thinks slowly, a feeling of joy and contentedness could arise from watching the most perfect of sunsets (potentially, such slow thought might even make the experience more calmly meditative). Finally, there may be cases in which effects of thought content overpower effects of thought speed and repetition, or vice versa, depending on the relative strength of each. That relative strength might depend on the extremity of the variables (e.g., are the thoughts only a little positive but extremely slow, or are they extremely positive and only a little slow?). It also might depend on other unexplored factors, such as context and individual differences.

Of course, thought content is not the only variable that could interact with mental motion. One factor that is likely to moderate the effects of mental motion is the situation and its content.

For example, fast thinking is likely to be especially pleasing when the demands of the situation are consistent with it (e.g., when success depends on functioning well under time pressure), but it is likely to be displeasing when the demands of the situation oppose it (e.g., when one is trying to fall asleep; see Harvey, 2001, 2002). Similarly, repetitive thinking is likely to be especially displeasing when the demands of the situation are inconsistent with it (e.g., when creativity is called for), but varied thinking may also be displeasing when the situation requires intense focus or vigilance.

RELATED APPROACHES

Our account of mental motion focuses on effects of thought speed and variability on mood and psychological experience. We now address the relationship between these aspects of mental motion and other related phenomena that have been explored in the literature. These include fluency, goal progress, and flow.

Perceptual Fluency

Research on perceptual fluency has examined effects of mental processing issuing from the ease or the difficulty of that processing. The general findings are that when a target is processed more easily, it is not only perceived as familiar (Jacoby & Brooks, 1984; Masson & MacLeod, 1997; Whittlesea, Jacoby, & Girard, 1990), but subjective evaluations of it are more positive and a “warm glow” of positive affect can result (e.g., Reber, Schwarz, & Winkielman, 2004; Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Object features that facilitate processing ease (or fluency) include figure-ground contrast, exposure duration, and stimulus repetition (e.g., Winkielman et al., 2003).

As a concept, perceptual fluency is related to mental motion. Both concern the idea that affect can result not only from what is processed or thought about, but also from how it is

processed or thought about. In both cases, the “what” can be something of neutral content and nevertheless can produce positive affect. And, in both cases, the “how” is linked to mental speed. Perceptual fluency is defined in part by the speed with which stimuli are recognized and evaluated (e.g., Winkielman et al., 2003), and mental motion is defined in part by the speed of thought. In both cases, the rule of thumb is that speed is good. From a fluency perspective, faster recognition and evaluation elicit more positive affect; from a mental motion perspective, faster thought elicits more positive affect.

Although the two concepts are related, a number of factors make them different. Perceptual fluency generally involves the speed with which external stimuli are recognized, whereas fast thinking involves the speed of internal thought. Thoughts can be fast or slow apart from exposure to external stimuli—for example, people can generate their own thoughts at either a rapid or a slow rate (as is the case, for example, with people experiencing mania or depression, respectively). In such cases of internally generated thought, we have reviewed evidence that positive affect still accrues when thoughts are fast as opposed to when they are slow.

Because fluency primarily concerns processing of a stimulus, the primary psychological response of concern involves a liking or preference for that stimulus. Mental motion, by contrast, primarily concerns thinking itself, as opposed to the target of thought, and the primary psychological response involves general affect. In the case of perceptual fluency, the feeling of liking a particular target may elicit a general feeling of positive affect. In the case of mental motion, the reverse may be true—a general feeling of positive affect may elicit the feeling of liking a particular target (for example, thinking fast about one’s own death might make that prospect less disturbing). Although this proposition has not been tested, past research has shown that general positive affect enhances liking for specific objects of judgment (e.g., Forgas &

Bower, 1987; Gorn, Goldberg, & Basu, 1993; Mayer, Gaschke, Braverman, & Evans, 1992; Schwarz & Clore, 1983).

Differing Predictions

The frameworks of perceptual fluency and mental motion also make somewhat different predictions. They diverge in the context of the most famous and well-studied variable that enhances perceptual fluency: repeated exposure. Numerous experiments have shown that such repetition produces positive attitudinal and affective responses (e.g., Bornstein, 1989; Harmon-Jones & Allen, 2001; Monahan, Murphy, & Zajonc, 2000; Zajonc, 1968). The mental motion account would suggest that repeated thoughts of the same stimulus should decrease, rather than increase, positive affect. A closer look at the literature on “mere exposure” effects clarifies this apparent inconsistency. That literature suggests that the positive effects of repeated exposure are most apparent when that exposure is unlikely to induce repetitive thinking. The effects typically emerge when stimulus repetition is subliminal (or of very brief duration) and when it involves unfamiliar and complex stimuli (e.g., Chinese ideographs and optical illusions; Bornstein, 1989; Zajonc, 1968, 2001). They also are more likely to emerge when the repeated stimulus is interspersed throughout a highly variable sequence rather than when it is shown repetitively in a homogeneous sequence (e.g., Harrison & Crandall, 1972). Indeed, positive affect is attenuated and boredom is more common than satisfaction when stimuli are shown over and over without other stimuli in between (e.g., Berlyne, 1970; Bornstein, Kale, & Cornell, 1990; Harrison & Crandall, 1972). All of this suggests an exception to the perceptual fluency account—an exception that is consistent with the mental motion account. Cases of repeated exposure in familiar and homogeneous sequences may enhance perceptual fluency, but they are likely to induce the feeling of repetitive thinking. As our account would predict, those cases diminish

positive affect.

In addition to making somewhat different predictions from the fluency account (e.g., about repetition) and also concerning somewhat different phenomena (e.g., thinking rather than stimulus processing), our account of mental motion also has introduced some experimental findings that do not fit comfortably in a fluency framework. In particular, positive effects of mental motion can occur even when stimuli are less rather than more fluent. For example, in our *I Love Lucy* experiment (described earlier), participants verbally narrated a television program at either its normal speed or at a fast speed (eight times normal). Although the episode is clearly more difficult to process and comprehend at eight times normal speed, participants reported more positive affect in that condition. Similarly, in experiments that we have conducted in which participants have been required to read at a fast or slow speed, participants have reported more positive affect in the fast condition (e.g., Pronin & Wegner, 2006). These findings suggest that easier processing does not necessarily lead to more positive affect than does more difficult processing, if the latter induces faster thought speed. A fluency account might address this point by suggesting that processing feels easier when thinking is fast than it does when thinking is slow. Such an argument raises the question of when the predictions of fluency rest on actual, or objective, ease of processing (as in repeated subliminal exposure) and when they rest on felt, or subjective, ease of processing (e.g., Winkielman et al., 2003). The question is particularly relevant in cases when the two types of fluency may be mismatched.

Processing Versus Thinking

Taking a more global perspective on the differences between fluency and mental motion, it is also worth noting that fluency generally concerns cognitive processing and is most commonly conceptualized as a low level, automatic, and nonconscious experience, whereas

mental motion generally concerns thinking and is typically conceptualized as a higher order, conscious experience.

This distinction between low-level processing and higher order thinking raises the question of whether mental speed and repetition exert similar effects when cognition is nonconscious (Dijksterhuis & Nordgren, 2006) or characterized by low-level processing instead of higher order thought. Although our focus in this article has been on thinking rather than processing, some research suggests that effects of mental motion might extend to lower level processing. Experiments involving stimulant drug use and physical exercise (reviewed earlier) suggest that those experiences not only elevate mood and induce the feeling of fast thinking, but they also increase more low-level characteristics of processing speed, such as reaction time and rapid visual information processing. With respect to mental repetition, experiments involving sequences of repeated exposure to the same short-duration stimuli (reviewed above) suggest that such low-level repetitive processing elicits more negative affect than when one views more varied sequences. Thus, it seems plausible that effects of mental motion may also occur in cases involving mere processing as opposed to more higher order thinking.

Goal Progress

Some research has demonstrated that goal progress and the velocity of approaching goals are associated with satisfaction and positive affect (whereas the lack of progress is associated with decreased satisfaction). People are pleased when they are making progress toward their goals—especially when they are making progress more quickly than expected (e.g., Carver & Scheier, 1990; also Hsee, Salovey, & Abelson, 1994). From a clinical perspective, research even suggests that increased goal striving and goal attainment can precipitate the onset of a manic episode (Johnson & Carver, 2006; Johnson et al., 2000; Nusslock, Abramson, Harmon-Jones,

Alloy, & Hogan, 2007). Other research also suggests that the feeling of psychological momentum (or being “on a roll”) may lead people to make more optimistic assessments (Markman & Guenther, 2007). This suggests that it might not be the fast and varied nature of thought that elicits positive mood, but rather the tendency for those aspects of thought to appear during goal progress, whereas slow and repetitive thinking might occur when goals are frustrated. Perhaps fast thinking (and a lack of repetitive thinking) elicit positive mood because they provide signals of goal progress.

According to this explanation, fast (and variable) thinking should not yield positive affect if they do not provide a signal as to goal progress or the rate of that progress. However, research evidence shows that fast and variable forms of thought elicit positive mood even when they provide no signs of goal progress.

In our variability and speed experiment, described earlier, participants were asked to read statements on a computer monitor. All participants were told that their task would take 15 min and that they would be paid and sent on their way at the end of that time (after completing a one-page questionnaire). To ensure that they could assess their temporal progress through the 15-min experiment, all participants were provided with a clock on their computer monitor. Each of the statements that participants read provided one trivial fact of neutral content. There was no thematic structure to their organization (for example, they did not collectively tell a story with a beginning, middle, and end), and therefore participants’ had no way of assessing their progress apart from the passage of time. The result was that participants displayed effects of thought speed and thought variability, even though they were fully aware that repetitive thinking and/or slow thinking did not signal poor progress (and that fast and/or variable thinking did not signal good progress).

Speed × Goal Experiment

In another experiment, we aimed to directly test the goal progress hypothesis. Participants ($N = 60$) were assigned to one of four conditions in a 2×2 (Speed $\times$ Goal) design. All participants were asked to count from 1 to 100 repeatedly. For our manipulation of speed, they were either asked to count fast (“one number after another without any pause in between”) or slow (“one number after another with about 10 seconds in between”). For our manipulation of goal progress, they were either given a clear goal (to count from 1 to 100 four times), or they were not given a clear goal and were simply told to count until told to stop. All participants were told that they would be interrupted at some point during their counting process to complete a quick questionnaire. That questionnaire was the PANAS mood measure (Watson et al., 1988). Participants were uniformly interrupted after 150 s. The experimenter listened through the door of the laboratory room so that she could record how far participants had counted up to that point. (Upon being interrupted, participants in the fast conditions had, on average, counted from 1 to 100 a total of 2.6 times, whereas those in the slow condition had counted as far as 23 once; there was no difference between the goal and no goal conditions.) Participants with a goal in the fast condition had been proceeding far more rapidly towards that goal than were their peers in the slow condition. They were 65% of the way there, whereas their peers were 6% of the way there.

A goal progress account would predict a Goal Progress $\times$ Speed interaction, whereby participants would experience more positive affect after counting fast with a goal than they would after counting slow with a goal (i.e., because they would have made much faster progress towards their goal in the fast condition than in the slow condition), but whereby they would experience no more positive affect after counting fast in the absence of any indication that they were making faster progress towards a goal. Our mental motion account instead offered the

simple prediction that participants would report more positive affect after counting fast than they would after counting slow.

As predicted by our mental motion account, participants' mood only showed a main effect of speed. They reported more positive mood after counting fast than they did after counting slow ($M_s = 3.63$ vs. 2.79 , $SD_s = 1.70$ and 1.00), $F(1, 56) = 5.40$, $p = .02$. There was no main effect of having a goal or not ($M_s = 3.13$ vs. 3.30 , respectively, $SD_s = 1.30$ and 1.61), $F(1, 56) = 0.30$, *n.s.* There also was no Speed $\times$ Goal Progress interaction, $F(1, 56) = 0.01$, *n.s.* Thus, participants were just as likely to report positive affect after thinking fast when that speed was unrelated to goal progress as they were when it represented faster progress towards a goal.

Apparently, mental motion can elicit positive affect even in the absence of its representing goal progress, and clear goal progress does not necessarily enhance the fast thinking effect.

Metacognitive Experiences

Nevertheless, the goal progress account could lend some insight into the metacognitive experiences (e.g., Schwarz, 2005) that might accompany fast and varied thinking. A fluency account might suggest that those experiences involve a feeling of ease. A goal progress account might suggest that they involve a feeling of mental progress or accomplishment. Potentially, that metacognitive experience could contribute to the positive effects of mental motion. Regardless of whether such hypothesizing proves true, it is important to recognize that the experiments that we have presented make clear that actual differences in the speed of progress, or even the perception of such differences, are not required to induce positive affect.

Flow

The concept of flow, by its very name, alludes to motion. Flow is a psychological state

involving a balance of high challenges and skills that is generally experienced as rewarding and reinforcing (Nakamura & Csikszentmihalyi, 2002). It occurs not only during physical activities (such as playing basketball), but also during mental activities, such as playing chess, composing music, or writing (Csikszentmihalyi, 1975; Csikszentmihalyi & Lefevre, 1989; MacDonald, Byrne, & Carlton, 2006; Perry, 2005). One might wonder, then, whether it is the psychological experience of flow, rather than that of fast or varied thinking, that produces the effects of mental motion. Indeed, flow states have been described with regards to their tendency to distort time perception (e.g., Csikszentmihalyi & Csikszentmihalyi, 1988), suggesting that fast thinking might be related to flow.

However, a number of aspects of the flow state make it different from that of mental motion (for reviews of flow, see Csikszentmihalyi & Csikszentmihalyi, 1988; Nakamura & Csikszentmihalyi, 2002). First, the distorted sense of time perception during flow is not experienced as fast thinking. People in flow do not report thinking fast (or slow) but rather they have the feeling that time has passed at an off-kilter rate—either fast or slow, depending on the particular case. Indeed, flow experiences involve being absorbed “in the moment,” often in an activity that is physically rather than verbally intense, to the point that conscious reflection about one’s mental motion is unlikely to occur even though one’s mind may be very active. Second, and relatedly, the rewarding nature of flow is often not consciously experienced as positive affect. For example, during flow people sometimes do not report feeling happy. Third, the psychological state of flow emerges when two basic conditions are met: when challenges are high, and when one’s ability to meet those challenges is high. Thus, people do not experience flow during easy tasks that they are perfectly well-suited to accomplish; in those cases, the theory asserts, apathy and boredom are more likely than flow.

Mental motion does not require this criterion of high challenge to produce positive affect. Thinking fast—even when such thinking is about something trivially simple—can elicit positive affect. For example, positive effects of fast or slow thinking occur during tasks as simple as counting upwards, and positive effects of variable or repetitive thinking occur during tasks as simple as slow reading. Taken together, these results indicate that mental motion—even when it involves a patently easy task—can elicit positive mood. This suggests that mental motion is distinct from flow, which Csikszentmihalyi (1990, p. 3) argues is best exemplified by cases “when a person's body or mind is stretched to its limits.”

The experience of flow is, thus, diagnostically, empirically, and subjectively different from that of mental motion. Nevertheless, there are some important relationships between the two concepts. One of those, “mental absorption,” suggests a factor that might enhance the effects of mental motion on positive affect.

As with the experience of flow, the experience of mental motion may contribute to a state of absorption. Absorption has been defined as a predisposition to experiences of “total attention” that “fully engage” mental resources (Tellegen & Atkinson, 1974, p. 268). Although absorption is defined as a trait, psychological states akin to it have been identified in cases of flow (Csikszentmihalyi & Csikszentmihalyi, 1988), peak experiences (Maslow, 1962), and experiential involvement (Wild, Kuiken, & Schopflocher, 1995). Each of these cases is characterized by heightened concentration and occupation of full attention.

Mental motion may contribute to a state of absorption. Indeed, studies have shown that the faster people are induced to think (in a signal detection task), the more mentally focused they are and the less their minds wander (Antrobus, Singer, & Greenberg, 1966). Absorption is posited to lead to positive affective changes and even to a state of bliss (for a review, see Cahn &

Polich, 2006). By contrast, lack of absorption, or states in which the mind is left to wander, may elicit dysphoria. When the mind is left to wander, it often goes where we wish it would not (Wegner, 1994) and often tends towards self-deflating thoughts (Smallwood & Schooler, 2006). Thus, to the extent that mental motion encourages a state of absorption, it may share some of the psychological benefits characteristic of flow. Promising new methods using functional brain imaging suggest techniques apart from self-report that can be used to measure mental absorption (Hasson, Yang, Vallines, Heeger, & Rubin, 2008) and mind wandering (Mason et al., 2007).

POTENTIAL UNDERPINNINGS OF THE EFFECT

There are three rough classes for thinking about how mental motion could affect psychological experience. In short, the effect might involve direct influences on brain chemistry, or it might be mediated by the peripheral nervous system (e.g., via physiological arousal), or it might occur by way of conscious reflection.

Direct Central Nervous System Effects

Although experiments have not explicitly studied the effects of fast thinking on brain chemistry or neurotransmitter release, a number of findings are relevant. Perhaps most germane is research on the activity of dopamine neurons. Phasic activation of dopamine neurons has been linked to exposure to stimuli that are novel, intense, or rewarding (Berridge & Robinson, 2003; Horvitz, 2002; Schultz, 2001). This suggests that increased dopaminergic activity may result from increased mental motion, as that motion is characterized by a high degree of exposure to changing (novel) stimuli that occur at a rapid (intense) rate.

The idea that mental motion elicits activation of the dopaminergic system fits nicely with the findings we have reviewed. Most notably, dopaminergic activity is associated with experiences of reward and pleasure (Kandel, Schwartz, & Jessell, 2000), thereby suggesting a

neural underpinning of the association between mental motion and positive affect. Indeed, increased dopaminergic activity has even been associated with manic euphoria (Depue & Iacono, 1989). Although the precise function of phasic dopamine responding is a matter of active theorizing, it seems to play a role in facilitating learning (e.g., Reilly, Noelle, Braver, & Cohen, 2002; Schultz, 2001). Novel (and rewarding) stimuli cue a need for learning, which may be why they are particularly likely to activate this system. It is possible that circumstances that require a good deal of learning may be especially likely to induce a high degree of mental motion because of the need to process a large amount of stimuli. The dopamine system may thus have a dual role in the processing of novel stimuli, both facilitating learning about those stimuli and making the process of learning affectively rewarding. Along these lines, it is also interesting to note that drugs that increase dopaminergic activity (e.g., cocaine) are generally both affectively rewarding and thought-speed enhancing (e.g., Asghar et al., 2003; Cocolles et al., 1987).

Peripheral Nervous System Mediated Effects

Increased mental motion, and in particular accelerated thought speed, also may influence psychological experience by virtue of its effects on physiological activity. This could occur via effects on physiological arousal or motor activity.

We already have noted that fast thinking is correlated with increased arousal and feelings of energy. Fast thinking might induce those responses by increasing overall neuronal activity (or by activating specific neuronal circuits) that, in turn, could elevate sympathetic tone and increase physiological arousal. Past research (Schachter & Singer, 1962) has suggested that arousal can be experienced as either affectively positive or negative, depending on other features of one's experience. In the absence of any cause for concern, arousal induced by fast thinking is likely to be labeled as affectively positive. However, other affective reactions, such as anger or anxiety,

are also possible depending on the context (it is interesting that the experiences of anger and euphoria are not always that far apart, as is sometimes the case in manic states).

Features that might lead one to label one's arousal negatively include the situation (e.g., does it suggest danger?) or accompanying subjective states (e.g., is the arousal accompanied by physical pain?). The present review suggests that the repetitive or variable nature of thoughts could be another such feature. Fast, repetitive thinking may be an innate response to experiencing a threat to survival (due to the situational demand for thoughts to be singularly focused and for a plan to be generated as rapidly as possible). Perhaps speed-induced arousal might be interpreted in a negative light (i.e., as a cue for anxiety) in the face of repetitive thinking because of this innate relationship.³ This scenario could also shed light on people's reactions to circumstances that do not genuinely pose a threat to survival, but that are inappropriately viewed as such. Those experiences, when they are extreme and frequent, characterize clinical anxiety disorders. And, as we have already noted, those disorders involve repetitive thinking, arousal, and irrational feelings of fear and danger.

It also is possible that fast thinking could induce positive mood by virtue of its effects on motor activity. To the extent that heightened mental motion leads people to do things such as tapping their feet or talking fast, that motor activity could affect emotional experience. It might do so indirectly (e.g., via effects on arousal), or it might do so more directly. Past research has demonstrated the role of motor activity in the experience of emotion (e.g., Niedenthal, 2007). In a number of the neurological, psychiatric, and pharmacologic examples we have provided (e.g., Parkinson's disease, bipolar disorder, stimulant drug use), rapid thought speed is accompanied by rapid motor activity, and slow thought speed is accompanied by slowed motor activity. We also have found in a number of experiments that manipulations of fast thinking induce at least

one sort of motor activity: fast talking (Pronin et al., 2008). Notably, rapid speech is a hallmark symptom of the manic state (e.g., American Psychiatric Association, 1994; Goodwin & Jamison, 1990). Perhaps fast talking or other motor responses could play a role in producing or enhancing the effects of fast thinking on emotional experience.

Conscious Reflection Effects

Another way that mental motion may affect mood is via people's conscious reflections on that motion. That is, it may be the reflective experience of one's mental motion that causes one to feel a certain way, rather than the fact of that motion in itself. People often reflect on their own cognitive activities (Metcalfe & Shimamura, 1994; Wegner, 1994). Such metacognitive experiences (e.g., Schwarz, 2005) have been shown to influence self-assessments and mood by virtue of people's lay theories about their meaning. The metacognitive experience of mental motion could be an example of one such experience that influences mood via lay theories.

Do people possess lay theories about the meaning of mental motion? In a scenario study, Pronin and Jacobs (2007) found that people not only possess such theories, but that their theories are consistent with the mood effects of mental motion. Participants read a description of an alleged student whose thoughts either were "jumping around" and "moving at an unusually fast pace" (while daydreaming or problem-solving, depending on version) or were more neutral in motion. Participants reported that the student whose thoughts were engaged in more motion would experience significantly more positive affect and energy than would the student whose thoughts were engaged in less motion, which is consistent with a lay theory account.

Naive theories about mental motion could be at least partially responsible for its positive effects. If one believes that a mind in motion is a sign of happiness and energy, one is likely to reflect on one's fast thinking as a sign of those positive experiences. If one believes that a mind

stuck is a sign of depression and low energy, one may report and feel those sentiments when one's own thoughts feel stuck. This possibility raises the interesting question of whether the psychological experience of mental motion could occur in the absence of that motion, if one falsely believed that it was occurring. That is, the lay theory account suggests that individuals might experience the exhilaration of fast and variable thinking without actually thinking fast or variably, so long as they become convinced that they are doing so. Indeed, such an illusion might be possible, given the difficulty that people have in accurately perceiving the passage of time and also the contextual malleability of human time perception (e.g., Ornstein, 1969; Zakay, 1989). Future research should examine the question of whether such misperceptions of thought speed and variability occur and, if they do, whether they affect mood and psychological experience.

IMPLICATIONS FOR PSYCHOTHERAPY

Over the past few decades, there has been a cognitive revolution in thinking about mental illness. Much of this theorizing stems from the basic idea, pioneered by Aaron Beck, that clinical disorders are characterized by various “maladaptive schemata, automatic thoughts, and biased interpretations” (Clark & Beck, 1989, p. 382; also Abramson, Seligman, & Teasdale, 1978; Beck, 1976; Beck & Emery, 1985). Research inspired by this theorizing has revealed that thoughts can be a source of mental disorders and a key point of attack in treating them (see Tyrer & Steinberg, 2005).

Thought speed and repetition are implicated in the psychological states associated with various mental disorders (e.g., mania, depression, and anxiety). We are hopeful that our theorizing will suggest a new direction, from a cognitive perspective, for exploration into these disorders' etiology and treatment.

The speed and repetition of thoughts, we suggest, could be manipulated in order to alter

and alleviate some of the mood and energy symptoms of mental disorders. The slow and repetitive aspects of depressive thinking, for example, seem to contribute to the disorder's affective symptoms (e.g., Ianzito et al., 1974; Judd et al., 1994; Nolen-Hoeksema, 1991; Philipp et al., 1991; Segerstrom et al., 2000). Thus, techniques that are effective in speeding cognition and in breaking the cycle of repetitive thought may be useful in improving the mood and energy levels of depressed patients. The potential of this sort of treatment is suggested by Pronin and Wegner's (2006) study, in which speeding participants' cognitions led to improved mood and energy, even when those cognitions were negative, self-referential, and decidedly depressing. It also is suggested by Gortner et al.'s (2006) finding that an expressive writing manipulation that decreased rumination (even while inducing thoughts about an upsetting experience) rendered recurrent depression less likely.

There also is some evidence suggesting that speeding up even low-level cognition may improve mood in clinically depressed patients. In one experiment, Teasdale and Rezin (1978) instructed depressed participants to repeat aloud one of four letters of the alphabet (A, B, C, or D) presented in random order every 1, 2, or 4 s. They found that those participants required to repeat the letters at the fastest rate experienced the most reduction in depressed mood.

Similar techniques could be tested for the treatment of other mental illnesses. For example, manipulations might be designed to decrease the mental motion of manic patients, perhaps by introducing repetitive and slow cognitive stimuli. Or, in the case of anxiety disorders, it would be worthwhile to test interventions aimed at inducing slow and varied thought (as opposed to the fast and repetitive thought characteristic of anxiety). The potential effectiveness of such interventions is supported by the fact that mindfulness meditation, which involves slow but varied thinking, can lessen anxiety, stress, and arousal (e.g., Eppley et al., 1989; Kabat-Zinn

et al., 1992).

Such treatment techniques may be criticized for seeming minimal and transient. However, short-term relief is useful, especially when symptoms are aversive or debilitating. Moreover, although existing experiments (Pronin & Wegner, 2006; Teasdale & Rezin, 1978) have involved brief, single-shot manipulations, it is quite possible that longer and more sustained manipulations would have more powerful and long-lasting effects. Such manipulations could be integrated into ongoing therapy regimens to provide an additional method of symptom relief and even long-term treatment.

In addition to providing new options for the treatment of mental disorders, these findings regarding mental motion may also offer new insight into the origins of certain mental disorders. The framework we have introduced here adds to existing models, such as the neurobiological, psychodynamic, cognitive-behavioral, and social, by suggesting that alterations in mental motion could be at least a partial cause of certain mental illnesses.

SUMMARIZING AND LOOKING AHEAD

The mental motion account describes the effects of thought speed and variability on mood and psychological experience. This account offers another route whereby cognition can affect mood, apart from the content of that cognition. Thoughts that are fast tend to induce positive mood more than thoughts that are slow. When fast thinking continually loops around to the same proposition (i.e., when it “goes nowhere”), however, the effect is more anxiety-provoking than uplifting. More generally, sequences of thought that are repetitive lower mood, whereas varied sequences elevate it.

This article offers a novel framework for exploring connections between mood and cognition. In so doing, it joins the ranks of other theories concerned with this interplay (e.g.,

CiOMPI, 2003; Forgas, 1995; Schwarz & Clore, 1983; Zajonc, 1980). By introducing thought speed as an independent variable with the potential to influence psychological experience, the present framework suggests novel hypotheses that can contribute to this literature. Together with this literature, which has generally focused on effects of mood on cognition (rather than vice versa), the present framework suggests that the relationship between affect and cognition can be bidirectional, such that moods not only can affect how we think and what we think about but they also can be affected by those factors.

Effects of thought speed and variability on mood may have adaptive value. For example, dangerous situations tend to elicit anxiety, which offers an affective cue that immediate withdrawal is a good idea. That anxiety may be produced by the dangerous situation itself, but it also might be triggered by fast and repetitive cognition. Dangerous situations could elicit fast and repetitive cognition, as it is probably adaptive for thoughts to be rapid and singularly focused during these situations. It has been argued that, for adaptive reasons, potentially dangerous situations elicit mentally focused and high-energy processing (CiOMPI, 2003). That sort of thinking precisely resembles the sort of fast, repetitive thinking that induces anxiety. It also is possible that anxiety might have the adaptive value of eliciting the sort of rapid and narrowly focused thought that could be useful in a dangerous situation. Either way, the more general point is that there may be evolutionary significance to the particular relationships that we observe between mental motion and psychological experience.

Future research will have much to explore. We have shown that thought speed can be influenced by both situational manipulations (e.g., fast reading, nicotine intake) and more traitlike ones (e.g., mania). It also can be affected more gradually, perhaps via increases in processing speed from youth to adulthood and decreases from adulthood to old age (Kail, 1991;

Salthouse, 1996). One question for further research involves whether these differences in the evocation of thought speed influence the mood consequences of thought speed. For example, chronic reductions in mental speed may, over time, have weaker effects than acute manipulations, and gradual changes may have weaker effects than sudden ones. This could be particularly true if thought speed effects are in part attributable to the surprisingness of deviations in speed (e.g., Whittlesea & Williams, 1998, 2000) or if adaptation effects occur. A related question concerns the relative impact of changes in thought speed (acceleration and deceleration), in comparison with absolute thought speed, on mood. That question also suggests the need for future work examining the importance of the subjective experiences (or feelings) of thought speed and thought variability versus the more objective experiences of those things. To that end, it would be useful to augment self-report measures of subjective thought speed and variability with novel neurological measures assessing objective thought speed and variability.

Finally, this article has primarily focused on consequences of mental motion for subjective experience, but other consequences are worth exploring. Future research should allow us to answer questions about the effects of mental motion on neural activation, motivation, the self-concept, and behavior. In the meantime, as we await the answers to those questions, there is at least one thing that can be said with some confidence: You are probably in a better mood right now if you quickly skimmed this article rather than if you slowly read it. Although a layperson might interpret that hypothesis as an indictment of the article's worth, it hopefully is a testament to its contribution.

Acknowledgments— Our gratitude goes to Amy Ricci for research assistance and to Aaron Beck, Jonathan Cohen, David DeSteno, Nicholas Epley, Ed Diener, Dara Friedman-

Wheeler, Joan Girgus, Philip Johnson-Laird, Reuven Dar, Oliver Sacks, Martin Seligman, and Daniel Wegner for thoughtful comments about this research.

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Fig. 1. Diagram illustrating the relationship between mental motion (thought speed and variability) and affective experience.

Fig. 2. Speed and valence experiment: means by condition (depressed vs. elated statements, slow

vs. fast thinking). Ratings were provided on 9-point scales. Error bars indicate one standard error. Reprinted from Pronin and Wegner (2006).

Fig. 3. Self-generated ideas experiment: means by condition (slow vs. fast thinking). Ratings of perceived thought speed were provided on a 9-point scale; ratings of psychological experience were provided on 5-point scales. Error bars indicate one standard error.

Fig. 4. Variability and speed experiment: means by condition (fast vs. slow) for participants induced to think repetitively. Ratings were provided on 9-point scales. Error bars indicate one standard error.

¹A third group of participants watched *I Love Lucy* at slow speed (70% of normal speed), but this condition failed to elicit slow thinking on our manipulation check.

²Participants also responded to a series of items assessing whether they felt anxious or depressed. These items were included to test our predictions about the role of the speed of repetitive thinking in anxiety versus in depression, and they are thus introduced in detail in the Anxiety Versus Depression section of this article.

³As noted earlier, it is interesting that near-death experiences can elicit euphoria rather than anxiety. Notably, people reporting those feelings report not repetitive thinking but rather expansively varied thinking, such as seeing innumerable instances throughout their lives “flash before them” (e.g., Noyes & Kletti, 1976, 1977).