Chapter 3
Dynamic Information Is Integral to Perception, Cognition, and Emotion

The human brain and its sensory systems are evolutionarily designed to be sensitive to movement and change and dynamic stimuli (Cacioppo & Freberg, 2016). Moreover, our higher-order perceptions of the world and thinking abilities appear to have their roots in perceptual systems that are sensitive to dynamic information (Fodor, 1972; Freyd, 1987; Shepard, 1981; Shepard & Podgorny, 1978). People, like most other animals, use dynamic information to increase their odds of survival in an often-dangerous environment.

Notably, however, psychologists have long tended to neglect the importance of dynamic information. As Freyd, Panzer, and Chang (1988, p. 395) have observed:

> "Much of what people encounter in everyday life is static from their point of reference: Cups rest on desks, chairs sit on floors, and books stand on shelves. Perhaps it is the very pervasiveness of static objects and still scenes that has been responsible for psychology's historical focus on the perception of static qualities of the world: shape and form perception, pattern recognition, picture perception, and object recognition. In apparent contrast to this [static] focus, there has been an increasingly popular emphasis on the perception of events, or patterns of change in the world."

As we will attempt to show in this chapter, people use dynamic information about moving objects and change to comprehend happenings in our own lives and experiences. In this chapter, we will present converging evidence from multiple lines of research to demonstrate that dynamic information is fundamental to human cognition and its construction of its understanding of the environment. This evidence includes: (1) theoretical and empirical work on representational momentum; (2) episodic memory, personal identity, stories and narrative; (3) the semantic differential; and (4) embodied cognition, metaphor, and emotions.

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Dynamic Information in Perception

As Freyd et al. (1988) pointed out, studies that have used the point light technique illustrate the ability of people to make use of dynamic perceptual information (Johansson, 1973). These studies have presented evidence that viewers can identify a person in the dark solely from his or her distinctive patterns of physical movement if the person has a small number of lights attached to his body as he or she moves (Cutting & Kozlowski, 1977).

Freyd and colleagues, as well as many other investigators have presented extensive evidences in numerous studies that people exhibit a representational momentum bias, a systematic bias, or dynamic memory distortion for moving objects. When viewing a sequence of static frozen-action photographs of simple dynamic scenes (e.g., a boy throwing a ball), for example, individuals tend to incorrectly remember seeing images that are displaced forward on an object's implied path of motion than what they had seen (for a review, see Freyd, 1987; Hubbard, 2005). Thus, memory of an object may incorporate its anticipated movement. Moreover, this magnitude of the forward displacement of the object depends on both its apparent velocity and acceleration and other apparent characteristics of its motion (Doerrfeld & Shiffrar, 2011; Hubbard, 1995, 1997, 2005). Hence, a person's higher-order perceptions and mental representations of simple dynamic scenes incorporate dynamic motion (i.e., representational momentum).

Dynamic Information in Autobiographical Memory, Mental Time Travel, and Narratives

People also use dynamic information when they think about past events or experiences they might have in the future. First, Tulving (2005) posited that episodic, autobiographical memory, as well as the ability to imagine possible futures, involves an autonoetic ability to be self-aware and to mentally "time travel." For example, when a person wants to remember past life experiences, the person must engage in a kind of mental time travel to go back in time and to reexperience events as if they were unfolding in the present. Similarly, the person must engage in a form of time traveling by projecting himself or herself forward and ahead into imagined futures when imaging possible futures. An idea that is similar, at least in part, has been proposed by theorists who have proposed that individuals engage in mental simulations of possible futures when anticipating their possible outcomes (Taylor, Pham, Rivkin, & Armor 1998; Tversky & Kahneman 1974).

Next, people use dynamic information when thinking about (constructing) their own personal life stories and identities. As Bruner (1991), McAdams and colleagues (e.g., Adler et al., 2015) and others have stated these stories and identities are narrative accounts of connected actions and events in experiences. In a more general sense, all stories, myths, and even excuses that people create for their behavior or

that of others are narrative accounts. All such narrative accounts are presentations of how past situations and events have led to present situations through a series of connected dynamic actions and events.

Semantic Differential

As mentioned, people use dynamic information when attempting to navigate throughout the physical and social world. They use dynamic information to organize and comprehend happenings in their lives. This idea is a basic assumption of Osgood, Suci, and Tannenbaum's (1957) semantic differential theory of linguistic meaning. In their theory, the linguistic meaning of all concepts and things can be represented by relative ratings on basic structural dimensions of judgments that include "activity" (e.g., the fast and slow of things), evaluation (the good and bad of things), and potency (the strong and weak of things). Interestingly, the following passage of Osgood (1969) seems to have anticipated the emphasis of the looming vulnerability model (LVM) on the role of dynamic information in the comprehension of threat:

> "Organisms without other specialized adaptive mechanisms (e.g., armor, coloration, poisons, etc.) which were unable to represent for themselves the good versus bad implications of the signs of things (antelope versus saber-toothed tiger), the strong versus weak of things (saber-toothed tiger versus mosquito) and the *quick* versus *slow of things* (saber-toothed tiger versus quicksand) would have *little chance of survival*" (Osgood, 1969, p. 195). (Italics added by the present authors).

Piaget's Model of Cognitive Development

In Piaget's (2007) cognitive developmental theory, dynamic information is integral to human thought because experiences with dynamic events such as changes and transformations provide the impetus for the development and change in schemas. Namely, we are compelled to develop and change our schemas to accommodate new elements that challenge prior expectations. Moreover, Piaget viewed the knowledge people obtained from such dynamic experiences (what he termed "operative" knowledge) to be far more important to their cognitive development than information regarding the static properties of things.

Dynamic Information Referenced and Conveyed by Nonverbal CUES

Evidence supporting the essential role of information about the dynamism of events to human thought also comes from research on nonverbal communication. From an evolutionary perspective, Edwards (1998) hypothesized that nonverbal

informational cues conveyed by individuals' facial expression would play a critical role in helping others to determine the time course of potential threats and the best actions to take in fight-flight situations. As predicted, her data revealed that participants could distinguish between impending and dissipating threats simply using nonverbal cues in facial expression as they were presented on displays. In addition, they were particularly sensitive to nonverbal cues conveyed in the early stages of facial expressions, which probably would be the stages of the events in which the informational value of facial expressions in conveying temporal cues would be of greatest adaptive value.

Embodied Cognition

According to conceptual models of embodied cognition, the dynamic information that is embodied in nonverbal cues such as facial expressions can also affect a person's own thoughts and appraisals. These models have posted that much of human thought is grounded in sensorimotor states such as patterns of perception and action. In other words, whenever a person thinks about given concepts (e.g., weight or height) or objects, the person experiences a corresponding activation of stored sensorimotor patterns that are closely associated with them. For example, when thinking about another individual who is tall, the person will tend to look up—while when thinking of someone who is short, he/she will tend to look down. Because of the strong associations, the opposite is also true. Whenever a person experiences the stored sensorimotor patterns that are associated with concepts, this can in turn help activate the person's thoughts or concepts that they reference. In short, a person's thinking about the world involves visual and sensorimotor processing (Barsalou, 2002, 2003a, 2003b; Briñol & Petty, 2008; Wilson, 2002).

In this vein, Glenberg (1997; Glenberg, Witt, & Metcalfe, 2013) has postulated an embodied cognition model that states that bodily states can be viewed as providing "action-based" meanings for human thought. Evidence for Glenberg's theory has been presented by a study by Tucker and Ellis (1998). Their participants were given the task of detecting whether a cup was right-side up or upside down. Supporting Glenberg's model, the participants were faster to identify whether the cup was right-side up or upside down when the cup's handle was on the same side of the display as the hand they used to respond. If the cup handle was on the right (or left) side, they responded faster with the right (or left) hand than when the handle was on the opposite side.

As another example, Reed and Farah (1995) gave participants the task of judging whether two visually presented human figures shown on a display depicted the same posture. The human figures in each case were the same except with regard to their precise relation to the orientation of the participant's own arms and legs. Supporting Glenberg's (1997) model, when participants were asked to move their arms they were better at detecting changes in the arm position of the figures, whereas when they were asked to move their legs, the pattern was reversed, and they were better at

detecting changes in the position of the leg of the figures. Reed and Farah's findings were extended in a neuroimaging study by Chao and Martin (2000). Participants were asked to view manipulable objects while lying passively in an fMRI scanner. The brain imaging results showed when participants viewed objects that they could manipulate, this activated grasping circuits.

Many more studies also support embodied cognition models. For example, Cacioppo, Priester, and Bernston (1993) showed that participants evaluated novel Chinese ideographs more favorably when bringing their arms closer (physical movement that is typically associated with approach tendencies) than when they were presented while extending or pushing their arms away (movement that is typically associated with avoidance). For another example, Wells and Petty (1980) examined attitude change while participants were instructed to either nod or shake their heads for a different ostensible task. Their results showed that participants agreed more with the attitude message when they nodded their heads while listening to these than when they shook their heads. Likewise, research by Laird and colleagues (Duclos et al., 1989; Laird, 1974) and Riskind and colleagues (Riskind, 1983, 1984; Riskind & Gotay, 1982) and others (Strack, Martin, & Stepper, 1988) has revealed that changes in facial expressions and physical postures can influence emotional states and judgments, as would be expected if such sensorimotor cues carry information that can significantly affect human thought. Note that some findings on posture effects not reviewed here have been difficult to replicate (Carney, Cuddy, & Yap 2010).

Embodied Metaphors

Nagle, a philosopher of science, aptly observed the role of metaphor in human thought when discussing how people develop and grasp new scientific concepts:

> "The widespread use of metaphors, whether they are dead or alive, testifies to a pervasive human talent for finding resemblances between new experiences and familiar facts, so that what is novel is in consequence mastered by subsuming it under established distinctions. (p. 107–108. Nagle, 1961)."

Nagle's suggestions foreshadow a great deal of subsequent theoretical and empirical work on the phenomenon of metaphor-based thinking. A vibrant body of work has proposed and tested the idea that a person's sensorimotor states and prior experiences with the world provide the person's mind with basic analogies or metaphors for thinking and understanding (Lakoff & Johnson, 1980; Landau, Meier, & Keefer, 2010). Lakoff (2015), one of the most influential thinkers regarding the role of metaphors in human thought, expressed these ideas in this way in a talk on "How the Brain Thinks: The Embodiment Hypothesis." As he stated, "Everyone living on earth" has experienced the world, "we have all experienced gravitation." Furthermore, Lakoff argues that these primal physical experiences with the world provide the "superstructure for all the conceptual systems that people develop thereafter."

Williams, Huang, and Bargh (2009) have proposed a similar "scaffolding" model of cognition. They propose that early preverbal sensorimotor experiences with the environment provide all people with simple concepts (e.g., warmth/coldness and heaviness/lightsness) that serve as analogies when people develop more complex concepts. For example, a person's sensorimotor experiences of weight would provide the person with a simpler, concrete concept that is used as an analogy and building block for more abstract concepts such as "importance."

Evidence supporting such suppositions has emerged in numerous studies. For example, Jostmann, Lakens, and Schubert (2009) asked participants to hold a clipboard while judging the importance of an issue. Participants who held a heavy clipboard were found to judge an issue as more important than did those who held a light clipboard. In another study, Kang, Williams, Clark, Gray, and Bargh (2011) found that participants who were primed by briefly touching a cold pack were less interpersonally trustful of other people than those who touched a warm pack, as indicated by the amount they invested in an anonymous partner on an economic trust game. Some studies by Slepian, Wesbuch, Rule, and Ambady (2012) manipulated the participants' tactile/proprioceptive sensations of toughness (e.g., squeezing a rough versus a soft ball) while asking them to categorize ambiguous faces as "male" or "female." Squeezing a rough ball was found to lead participants to be more likely to categorize the ambiguous faces as male. In other studies, Briñol, Petty, and Wagner (2009) showed that body postures can influence confidence in thoughts. When participants were placed into a confident posture (sitting with an erect back while pushing their chest out), this increased confidence in thoughts more as compared to when they were placed into a doubtful posture (their back curved).

The importance of dynamic information in human thought comes from a recent study by Miles, Nind, and Macrae (2010). They examined the relationship between thinking about the past as opposed to the future and body lean. In particular, they assessed participants' body movements while giving them instructions to either imagine a future scenario or to recall events from the past. When participants were instructed to imagine a future scenario, they tended to lean slightly forward, whereas when they were instructed to recall events from the past, they tended to lean slightly backward.

Thus, these findings imply that people understand the idea of events that may occur in the future by means of the analogy of objects that are ahead and coming closer. In contrast, they understand the idea of events in the past with the analogy of objects that are receding and behind us in physical space.

In sum, dynamic information is integral to our perceptual representations, autobiographic memories, and personal narratives. It is a basic dimension for linguistic meaning (Osgood et al., 1957). We can read subtle dynamic cues about unfolding events from the facial expressions of others. Moreover, dynamic information from sensorimotor states provides a grounding for the superstructure of our conceptual systems.

Dynamic Information and Emotional Experience

The idea that dynamic information is indispensable to how people think is also supported by work that suggests that the dynamism of emotion-eliciting stimuli plays an integral role in emotions. For one example, Lazarus's (1991) theory of emotion posited that emotions are elicited by cognitive appraisals of the changing "relational meaning" of changes in the environment (for a more detailed discussion, see Chap. 5 of the role of approach movement in cognitive appraisals). Relational meaning refers to the idea that people continually evaluate the continually changing implications of their transactions with an environment that can continually "change over time and circumstances."

In a similar manner, Baumeister and Bratslavsky (1999) and Ortony, Clore, and Collins (1988), as well as other emotions theories, have posited that emotional experiences are triggered by *changes* in stimuli (or events) rather than the stimuli themselves. As Baumeister and Bratslavsky (1999) put this:

> "Clearly, emotions generally involve strong, rapid, and temporary responses by the organism. They are transitory states marked by physiological arousal, and as such they seem poorly suited to recognize stable, enduring circumstances—but very well suited to response to important changes. Emotions should therefore be plentiful in times of change, but, once the situation stabilizes, they will taper off (p. 53)."

Along similar lines, the self-regulatory model of Carver and Scheier's (1990) proposed that emotional reactions depend on the extent that people perceive a rapid dynamic rate of change in their progress toward positive goals or away from negative goals. More specifically, a person experiences more intense feeling of positive emotion when rapid progress is being made *toward* positive goals, and more intense feelings of negative emotion when a slow rate of progress is being made *away* from negative goals. Interestingly, one makes slower progress away from negative goals when a threat is rapidly approaching. Thus, Carver and Scheier's model is consistent with the LVM.

Hsee and Abelson (1991) proposed and showed that the extent that people report satisfaction or dissatisfaction with outcomes depends on the rate of change with which these outcomes have improved or worsened. For example, when a person achieves a high standing in an undergraduate class, the person experiences greater satisfaction when their class standing has rapidly improved than when it has improved more slowly or when it was always high. Indeed, they showed that a small but rapid rise in class standing or other positive outcomes produced more satisfaction than a larger but slower rise. Similarly, experiencing a rapid drop in outcomes such as class standing produces more dissatisfaction than a slower drop or outcomes that have constantly been low.

Along similar lines, Aronson and Linder (1965) tested a "gain-loss model" of interpersonal attraction that was stimulated by Spinoza's (1996) philosophical analysis of emotion. Their research suggested that people tend to like a person far more who's liking for them has grown over time than a person who has always liked

them. Likewise, they tend to dislike a person far more who comes to dislike them after initially liking them, as compared to a person who has always disliked them.

According to Helson's (1964) adaptation level model, a person's judgments of intensity are made with reference to an implicit benchmark (or psychological neutral point) called the adaptation level. Exposure to an unchanging stimulus causes the stimulus to lose intensity as the adaptation level changes. For example, if a person were to place his or her hands in cold water, the water eventually begins to feel less cold as they adapt to it. If the person were subsequently to place his or her hands in water that was actually just warm, it might then feel hot. Likewise, if the person were to place his or her hands in hot water, the person's hands would adapt to it, and if the person then placed his or her hands in warm water it would feel cold.

Thus, Helson's (1964) theory can be related to the ideas of Baumeister and Bratslavsky (1999) and other emotion theorists that protracted exposure to static unchanging stimuli results in emotion that is short-lived and that tapers off as adaptation occurs. One implication of these ideas for anxiety is that when threat stimuli are static or unchanging they would theoretically have diminishing emotional impact as adaptation occurs. On the other hand, when threats are dynamically intensifying (i.e., looming), this can maintain and even intensify emotion.

Helson's (1964) model also helped to inspire a "hedonic treadmill" theory of happiness and subjective well-being proposed by Brickman and Campbell (1971). Their theory predicts that even major life-changing events have a short-lived impact on a person's happiness because adaptation takes place. Consistent with this idea, Brickman, Coates, and Janoff-Bulman (1978) presented evidence that the effects of events such as winning a lottery or becoming totally disabled on happiness had relatively temporary effects on happiness.

Kahneman and Tversky's (e.g., 1979) prospect theory of economic choice behavior also emphasizes the importance of prior psychological neutral points or benchmarks. The theory states that people don't only judge the attractiveness of choice alternatives by their absolute values, but by comparing these absolute values with their prior neutral points or benchmarks. For example, a person who expects to pay $200 for a product and finds one on sale for $150 will find that very attractive; however, if the person will not feel that way if the person has expected to pay $100 for same item that is on sale for $150. Kahneman and Tversky suggested that it isn't absolute values but the differences between present values and prior benchmarks that are the actual "carriers of value" that most strongly influence choice behaviors.

Synthesis and Conclusions

In short, information about the dynamism of events is fundamental to human cognition and to the warp-and-weave of its construction of its understanding of the environment. People navigate their paths through the physical and social world using dynamic information. In addition, the emotional impact of stimuli appears to depend

on their dynamism and on changes that occur in them rather than the stimuli alone. Emotional reactions to static (constant) stimuli tend to taper off and be short-lived since one's psychological neutral point tends to adapt to them.

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