

Chapter 2

Ecological Validity

And it then becomes necessary to point out that there is something else—a ‘truthlikeness’ or ‘verisimilitude’—with a calculus totally different from the calculus of probability with which it seems to have been confused.

—Karl Popper (p. 219)

Whilst traditional tests of executive function have been remarkably useful, we are now at the stage in the development of the field where one could create bespoke tests specifically intended for clinical applications rather than adapting procedures emerging from purely experimental investigations, as has been almost exclusively the case until recently.

—Burgess et al. (2006, p. 194)

Reason is and ought to be the slave of passions, and can never pretend to any other office save to serve and obey them.

—David Hume (1739/1978, p. 415)

1 Introduction

Over the past twenty years, neuropsychology has experienced a shift in assessment from lesion localization to assessment of everyday functioning (Hart and Hayden 1986; Heaton and Pendleton 1981; Long 1996; Manchester et al. 2004). Clinical neuropsychologists are increasingly being asked to make prescriptive statements about everyday functioning (Chaytor and Schmitter-Edgecombe 2003; Gioia and Isquith 2004; Olson et al. 2013; Rabin et al. 2007). This new role for neuropsychologists has resulted in increased emphasis upon the ecological validity of neuropsychological instruments (Chaytor et al. 2006). As a result, neuropsychologists have been experiencing a need to move beyond the limited generalizability of results found in many earlier developed neuropsychology batteries to measures that more closely approximate real-world function. A difficult issue facing neuropsychologists interested in assessment of real-world functioning is the question of what constitutes an ecologically valid assessment. In the psychology literature, the term “ecological validity” was

initially understood as the ability to generalize results of laboratory-based (i.e., controlled experiments) to events naturally occurring in the real world (Brunswick 1955). In cognitive psychology, this question was raised in Ulrich Neisser and Mahzarin Banaji's spirited exchange, which revolved around (1) Neisser's (1982) contention that the laboratory imposes an artificial situation that does not represent the everyday world; and (2) Banaji's rebuttal that the experimental setting should be kept "pure" and cleansed of the murky details that characterize ecologically valid settings (e.g., Banaji and Crowder 1989). In the 1990s, neuropsychologists developed a definition of ecological validity that was specific to neuropsychology (Sbordone 1996; Franzen and Wilhelm 1996) and a number of ecologically valid assessment tools were developed (Marcotte and Grant 2009; Tupper and Cicerone 1990, 1991).

In addition to these historical issues and emerging definitions for ecological validity in neuropsychological assessments, there is a growing desire for "ecological validity" to be need more than simple cosmetic changes to represent real-life situations. Instead, there is a more fundamental issue that the majority of neuropsychological assessments focus upon various aspects of veridical constructs and neglect the reality that real-life veridical decision making is merely a tool subordinate to adaptive decision making. New issues for ecological validity can be found in Goldberg's (2000) contrasting of veridical and agent-centered decision making; as well as Burgess et al.'s (2006) discussions of the need for "function-led approaches" to neuropsychological models and assessments. There is also a growing interest in the interplay of "cold" cognitive processing (linked to dorsal and lateral regions of the prefrontal cortex) of relatively abstract, context-free information, and "hot" cognitive processing (linked to the functioning of the orbitofrontal cortex) involved when emotionally laden information is present (Fonseca et al. 2012; Kerr and Zelazo 2004; Rossier and Sahakian 2013; McDonald 2013; Unsworth et al. 2005).

The plan of this chapter will be as follows: In Sect. 2, "The Everyday/Laboratory Research Conflict," there will be a review of Neisser and Banaji's debate about whether the laboratory imposes an artificial situation that does not represent the everyday world. In Sect. 3, "Early Attempts at a Neuropsychology-Specific Definition of Ecological Validity," the discussion will be extended to early attempts to offer a definition of ecological validity that was specific to neuropsychology. Section 4 builds on ideas from Burgess and colleagues (2006) and presents "Construct-Driven and Function-Led Approaches to Neuropsychological Assessment." Herein, the case of Burgess et al. (2006) is presented that argues for a "function-led approach" to models and assessments that proceed backward from a directly observable everyday behavior to measure the ways in which a set of actions lead to a given behavior in normal and disrupted processing. In Sect. 5, "Veridical and Actor-Centered Decision Making," the reader is presented with Goldberg's (2000) contention that existing neuropsychological procedures assess veridical, but not agent-centered, decision making, which limits the tests' ecological validity because most real-life decision making is agent-centered and adaptive, rather than veridical. In Section 6, "Importance of Affective States for Cognitive Processing," a final addition for improving our understanding of ecological validity is proffered that includes an enhancement of

ecological validity via the inclusion of the interplay of “cold” cognitive processing of relatively abstract, context-free information, and “hot” cognitive processing involved when emotionally laden information.

2 The Everyday/Laboratory Research Conflict

The issue of ecological validity in psychological assessment has been expressed a number of times over the years via discussions of the limitations of generalizing sterile laboratory findings to the processes normally occurring in people’s everyday lives. In 1978, Neisser proffered an opening address at the first International Conference on Practical Aspects of Memory, in which he argued for an ecologically valid approach to memory assessment (published in Neisser 1982). Neisser offered three main challenges to memory research: (1) the traditional approach has resulted in only few new discoveries; (2) the preoccupation with broad theoretical issues (e.g., mechanisms of forgetting) has resulted in a neglect of questions relevant to everyday life (e.g., the forgetting of appointments); and (3) the majority of the experiments were conducted in artificial settings and employed measures that have few counterparts in everyday life (e.g., unrelated wordlists). In Neisser’s view, such research lacks “ecological validity.” Hence, Neisser was arguing that the findings from many traditional cognitive assessments have not been demonstrated to generalize beyond the narrow laboratory context.

It is important to note, however, that an essential tension exists between persons striving for ecological validity and persons interested in maintaining experimental control. In 1989, Banaji and Crowder countered Neisser’s arguments with the claim that the naturalistic study of memory has not been productive. They contended that the ecological approach to neurocognitive research is inconsequential and that scientific progress necessitates greater emphasis on experimental control. As Banaji and Crowder have challenged, if neurocognitive measures fail to establish internal validity, then one can conclude nothing from study findings. Following Banaji and Crowder’s paper, a special issue of the *American Psychologist* (1991) was devoted to replies to the original article. A number of perspectives were presented related to the issue of whether memory capabilities that are called upon in the laboratory are similar to real-life tasks. From a neuropsychological perspective, these discussions would have been aided by then-current discussions in the neuropsychological literature on prospective memory (Meacham 1982) and the ways in which various environmental factors may define how memory deficits interact with other deficits (Schacter 1983). In addition to memory, there were other domains being discussed at that time from an ecological perspective: problem solving (Sinnott 1989); intelligence (Rogoff and Lave 1984; Sternberg and Wagner 1986); and categorization (Neisser 1987). In 1993, Barbara Wilson (1993) reflected on the Neisser and Banaji debate and called for a rapprochement (at least for neuropsychologists) that included a comprehensive range of neuropsychological assessments for evaluating the patient’s current neuropsychological condition and potential for

returning to everyday life in a community. While there was a great deal of controversy over whether cognitive assessment should emphasize standardized, laboratory-based methods, or more observational and naturalistic assessment practices (e.g., Banaji and Crowder 1989; Conway 1991; Neisser 1978), the debate has since subsided (deWall et al. 1994).

An issue that came up during the discussion of cognitive assessment of everyday functioning was the specificity of many of the skills needed for activities of daily living. Given the great variability among the skills needed for various daily activities, there may not be enough similarity available to allow for an adequate study of the skills (Tupper and Cicerone 1990, 1991). Williams (1988) suggested that neuropsychologists interested ecological validity need to define clusters of skills needed for a given task relative to whether the skill is used in many tasks across environments (i.e., generic) or used in new tasks in a limited number of environments (i.e., specific). According to Williams, this would allow for the use of traditional testing procedures for assessing skills that are used in many tasks across environments. However, functionally based test measures would need to be developed for skills used in new tasks in a limited number of environments. The work of Williams and others prompted a need for a more refined definition of ecological validity for the theory and praxes of clinical neuropsychology.

3 Early Attempts at a Neuropsychology-Specific Definition of Ecological Validity

The traditional approach to neuropsychological assessment included measures used for the purpose of diagnosing brain lesions or uncovering the behavioral consequences of those lesions (Lezak 1983). However, in the 1980s, a change in referral questions marked a shift from the “deficit measurement paradigm” described by Lezak to a new paradigm included emphasis upon functional competence (Chelune and Moehle 1986). The advent of neuroimaging changed the way clinical neuropsychologists answered referral questions. **Clinical neuropsychologists have experienced** a shift in assessment from lesion localization to assessment of everyday functioning (Long 1996). **With the advent and development of advanced technologies in the clinical neurosciences, there was decreased need for neuropsychological assessments to localize lesions and an increased need for neuropsychologists to describe behavioral manifestations of neurological disorders.** Clinical neuropsychologists were increasingly being asked to make prescriptive statements about everyday functioning (Sbordone and Long 1996). This new role for neuropsychologists resulted in increased emphasis upon the ecological validity of neuropsychological instruments (Franzen and Wilhelm 1996).

In his presidential address to the International Neuropsychology Society in 1981, Rourke (1982) described a gradual change in the practice of clinical neuropsychology from diagnostic assessments to more functional examinations. According to Rourke, the history of neuropsychology could be understood (at that point in time) as

a three-stage continuum: (1) *static phase*, during which neuropsychologists focused more on relating performance on cognitive tests to well-documented lesions than to the cognitive nature of the tasks that were administered; (2) *cognitive phase*, during which neuropsychologists began analyzing the cognitive task demands of various neuropsychological measures; and (3) *dynamic phase*, during which neuropsychologists began taking into consideration both brain development and individual differences. Support for Rourke's continuum is evidenced by the neuropsychologists in the 1980s that began to recognize the growing need for neuropsychological measures that could provide sufficient information concerning their effects on a functional level (Mapou 1988). This became especially important as neuropsychologists observed that brain imaging and other neurological techniques becoming more sophisticated. They reasoned that the advent and development of neuroimaging would result in a decrease in neuropsychological assessments for localizing lesions and an increase in use for behavioral manifestations of neurological disorders (Costa 1983). As a result, the content of neuropsychological batteries needed to be re-evaluated and the clinical utility of the assessment was less determined by its sensitivity to the organic integrity of the brain. Instead, neuropsychological assessments should be evaluated based upon the extent to which each assessment provides information useful in the prediction of functional consequences (Mapou 1988). An unfortunate limitation of this period is that efforts to operationalize assessment models tended to focus on laboratory or clinical performance tests (Welsh and Pennington 1988; Welsh et al. 1991), with their inherent construct and measurement problems (Pennington et al. 1996; Rabbit 1997).

In the neuropsychological literature, the terms "ecological validity" and "everyday functions" can be found in increasing use during the 1990s (Tupper and Cicerone 1990, 1991). During that time, neuropsychologists were progressively aware of the importance of their findings for real-world activities (Sbordone and Long 1996). As a result, there were amplified discussions in the literature evaluating neuropsychological tests and assessment techniques. An unfortunate limitation for neuropsychologists interested in assessing everyday functioning was the lack of definitional specificity of the term "ecological validity" (Franzen and Wilhelm 1996). Early attempts to define ecological validity for neuropsychological assessment emphasized the functional and predictive relation between a patient's performance on a set of neuropsychological tests and the patient's behavior in everyday life. Hence, an ecologically valid neuropsychological measure has characteristics similar to a naturally occurring behavior and can predict everyday function (Sbordone 1996). Franzen and Wilhelm (1996) refined the definition of ecological validity for neuropsychological assessment via an emphasis upon two requirements: (1) *verisimilitude*: the demands of a test and the testing conditions resemble demands in the everyday world of the patient; and (2) *veridicality*: the performance on a test predicts some aspects of the patient's functioning on a day-to-day basis. According to Franzen and Wilhelm (1996), "verisimilitude" overlaps with face validity and describes the "topographical similarity" (i.e., theoretical relation) between the method by which the data were collected and the skills required for successful praxes in the natural environment of the patient

(Franzen 2000). In addition to the task demands of a given neuropsychological task, verisimilitude requires a consideration of the testing environment and methods. While a neuropsychologist may argue that the task demands of learning a recalling a list of words has “theoretical” similarity to the sorts of tasks that a patient might be required to perform in their everyday lives, the actual “praxes” of this task may be more representative of a laboratory experiment: words presented at a controlled rate, the task is performed free from distractions, and there are repeated opportunities to learn the list of words. Hence, the administrative controls that are in place to ensure reliability and internal validity may underestimate the implications of a patient’s cognitive difficulties in everyday life and overestimate functional difficulties (e.g., patient may use compensatory strategies in their everyday world).

To require the verisimilitude component of ecological validity for a neuropsychological assessment means that the measure needs to resemble a task the patient performs in everyday life. Further, the test is developed while maintaining the relationship between task demands and the prediction of real-world behavior (Spooner and Pachana 2006). Early discussions of verisimilitude in neuropsychology emphasized that the technologies current to the time could not replicate the environment in which the behavior of interest would ultimately take place (Goldstein 1996). Further, most neuropsychological assessments in use today are yet to be validated with respect to real-world functioning (Rabin et al. 2007). There are a few examples of neuropsychological assessments that emphasize verisimilitude in approximating cognitive constructs: (1) *attention*, the Test of Everyday Attention (Robertson et al. 1996); (2) *executive function*, the Behavioral Assessment of the Dysexecutive Syndrome (Wilson et al. 1996); (3) *memory*: the Rivermead Behavioral Memory Test (Wilson et al. 1985); and (4) *prospective memory*, Cambridge Test of Prospective Memory (CAMPROMPT; Wilson et al. 2004). It is important to note that these “verisimilitude” assessments are somewhat conflicted in that while they focus on cognitive “constructs” (e.g., attention, executive function, memory), they are used for identifying “functional” abilities (Chaytor and Schmitter-Edgecombe 2003). Hence, an obvious question for the verisimilitude approach is whether the assessment of functional capacity can offer the neuropsychologist data relevant for understanding cognitive constructs disrupted relative to brain dysfunction.

Franzen and Wilhelm’s (1996) second requirement for establishing an ecologically valid neuropsychological assessment is that it meets the requirements of “veridicality,” or the degree to which performance on a test predicts some aspect of the patient’s everyday functioning. An unfortunate limitation of most neuropsychological tests is that little is known about prediction of everyday behavior from neuropsychological tests. Further, such an analysis is complicated by the difficulties inherent in capturing an individual’s functioning in a reliable and valid numerical fashion. A number of studies have correlated neuropsychological test data with the patient’s vocational status (Bayless et al. 1989) and/or vocational functioning (Lysaker et al. 1995). Another approach has been to correlate neuropsychological test data with rating scales designed to assess aspects of daily functioning (Dunn et al. 1990). An unfortunate limitation of the veridicality approach is that direct

parallels between the demands found on traditional neuropsychological assessments and functional performance are often not evident (Makatura et al. 1999; Wilson 1993; Wilson et al. 1989).

4 Construct-Driven and Function-Led Approaches to Neuropsychological Assessment

A recent development in the ecological validity discussion was introduced by Burgess and colleagues (2006) when they presented an analysis of neuropsychology's adaptation of outmoded conceptual and experimental frameworks. Burgess et al. proffer current construct-driven tests as examples of measures that fail to represent the actual functional capacities inherent in cognitive (e.g., executive) functions. They point out that cognitive construct measures such as the Stroop and Tower of London were not originally designed to be used as clinical measures (Burgess et al. 2006). Instead, these measures were found to be useful tools for cognitive assessment and normal populations and then later found their way into the clinical realm to aide in assessing constructs that are important to carrying out real-world activities. For example, if a patient's performance on the Stroop revealed difficulty inhibiting an automatic, over learned response, a neuropsychologist may be compelled to report caution relative to an aging patient's driving—safe driving of an automobile includes the ability to withhold an over learned behavior to press the brakes if a traffic light turns red when the driver is halfway through the intersection. An unfortunate limitation of this approach to predicting everyday functioning is that it forces the neuropsychologist to rely on measures designed for other purposes. Goldstein (1996) questioned this approach because it is difficult to ascertain the extent to which performance on measures of basic constructs translates to functional capacities within the varying environments found in the real world. A decade later, Burgess et al. (2006) agree and argue that a further issue is that we need assessments that further our understanding about the ways in which the brain enables persons to interact with their environment and organize everyday activities. Instead of using the terms “verisimilitude” and “veridicality” when discussing “ecological validity,” they use the term “representativeness” to discuss the extent to which a neuropsychological assessment corresponds in form and context to a real-world (encountered outside the laboratory) situation. They use the term “generalizability” to discuss the degree to which poor performance on a neuropsychological assessment will be predictive of poor performance on tasks outside the laboratory.

For example, one of the most widely used measures of executive function is the Wisconsin Card Sorting Test (WCST Heaton et al. 1993). The most extensive normative data are derived from an administration of the WCST that utilizes paper cards. The stimulus cards are administered by an experimenter on one side of a desk as he/she faces a participant on the other side of the desk. Participants are presented with a number of stimulus cards and instructed to match these stimulus cards to

target cards. Although participants are not told how to match the cards, they are informed whether a particular match is correct or incorrect. It is important to note that the WCST (like many paper-and-pencil tests in use today) was not originally developed as a measure of executive functioning. Instead, the WCST was preceded by a number of sorting measures that were developed from observations of the effects of brain damage (e.g., Weigl 1927). Nevertheless, in a single study by Brenda Milner (1963), patients with dorsolateral prefrontal lesions were found to have greater difficulty on the WCST than patients with orbitofrontal or nonfrontal lesions. However, the majority of neuroimaging studies have found activation across frontal and nonfrontal brain regions and clinical studies have revealed that the WCST does not discriminate between frontal and nonfrontal lesions (Nyhus and Barcelo 2009; Stuss et al. 1983). Further, while data from the WCST do appear to provide some information relevant to the constructs of “set shifting” and “working memory,” the data do not necessarily offer information that would allow a neuropsychologist to predict what situations in everyday life require the abilities that the WCST measures.

Burgess et al. (2006) suggest that future development of neuropsychological assessments should result in tests that are “representative” of real-world “functions” and proffer results that are “generalizable” for prediction of the functional performance across a range of situations. According to Burgess et al. (2006) a “function-led approach” to creating neuropsychological assessments will include neuropsychological models that proceed from directly observable everyday behaviors backward to examine the ways in which a sequence of actions leads to a given behavior in normal functioning; and the ways in which that behavior might become disrupted. As such, call for a new generation of neuropsychological tests that are “function led” rather than purely “construct driven.” These neuropsychological assessments should meet the usual standards of reliability, but discussions of validity should include both sensitivity to brain dysfunction and generalizability to real-world function.

4.1 Function-Led Tests that Are Representative of Real-World Functions

A more ecological approach to neuropsychological assessment is to move from construct-driven assessments to tests that are “representative” of real-world “functions” and proffer results that are “generalizable” for prediction of the functional performance across a range of situations. According to Burgess et al. (2006), a “function-led approach” to creating neuropsychological assessments will include neuropsychological models that proceed from directly observable everyday behaviors backward to examine the ways in which a sequence of actions leads to a given behavior in normal functioning; and the ways in which that behavior might become disrupted. As such, he calls for a new generation of neuropsychological tests that are “function led” rather than purely “construct driven.” These

neuropsychological assessments should meet the usual standards of reliability, but discussions of validity should include both sensitivity to brain dysfunction and generalizability to real-world function. A number of investigators have argued that performance on traditional neuropsychological construct-driven tests (e.g., Wisconsin Card Sorting Test, Stroop) has little correspondence to activities of daily living (Bottari et al. 2009; Manchester et al. 2004; Sbordone 2008). According to Chan et al. (2008), most of these traditional construct-driven measures assess at the veridicality level and do not capture the complexity of response required in the many multistep tasks found in everyday activities.

4.2 Real-World Assessments Using the Multiple Errands Tasks: Potential and Limitations

A number of function-led tests have been developed that assess cognitive functioning in real-world settings. For example, Shallice and Burgess (1991) developed the multiple errands test (MET) as a function-led assessment of multitasking in a hospital or community setting. Participant performs a number of relatively simple but open-ended tasks (e.g., buying particular items, writing down specific information, traveling to a specific location) without breaking a series of arbitrary rules. The examiner observes the participant's performance and writes down the number and type of errors (e.g., rule breaks, omissions). The MET has been shown to have increased sensitivity (over construct-driven neuropsychological tests) to elicit and detect failures in attentional focus and task implementation. It has also been shown to be better at predicting behavioral difficulties in everyday life (Alderman et al. 2003). However, there are a number of unfortunate limitations for the traditional MET that are apparent in the obvious drawbacks to experiments conducted in real-life settings. Function-led neuropsychological assessments can be time-consuming, require transportation, involve consent from local businesses, costly, and difficult to replicate or standardize across settings (Logie et al. 2011; Rand et al. 2009). Further, there are times when function-led assessments in real-world settings are not feasible for participants with significant behavioral, psychiatric, or mobility difficulties (Knight and Alderman 2002).

In summary, early discussions of verisimilitude in neuropsychology emphasized that the technologies current to the time could not replicate the environment in which the behavior of interest would ultimately take place. Today, most neuropsychological assessments continue to represent outdated technologies and static stimuli that are yet to be validated with respect to real-world functioning. While much of the early discussion of ecological validity reflected an emphasis upon veridicality and verisimilitude, Burgess and colleagues (2006) have updated the discussion to include differentiating of construct-driven assessments from function-led neuropsychological assessments.

5 Veridical and Actor-Centered Decision Making

Over the past 30 years, there has been growing concern in the field of neuropsychology about the ecological validity of neuropsychological tests. While this concern often takes the prosaic form of elaborating the cognitive tasks with the surface features of real-life situations, little is done to adjust the assessments to measure real-world adaptive decision making. Goldberg and Podell (2000) contend that neuropsychological assessments need more than simple cosmetic changes to represent real-life situations. Instead, there is a more fundamental issue that the majority of neuropsychological assessments focus upon various aspects of veridical decision making and neglect the reality that real-life veridical decision making is merely a tool subordinate to adaptive decision making (Goldberg and Podell 1999). Given that many existing neuropsychological tests assess more narrow veridical than real-world adaptive (Goldberg (2012) also refers to this as “agent-centered”) decision making, the neuropsychologist may not be collecting the data relevant to documentation of the full essence of the patients cognitive strengths and weaknesses.

The distinction made by Goldberg and colleagues (1999, 2000, 2005, 2009, 2012) includes a dichotomy between “veridical” and “agent-centered” cognition. By “veridical,” Goldberg means that cognition is directed at solving problems characterized by agent-dependent choices that are fundamentally “true” and “false.” These choices range from simple (e.g., $2 + 2 = ?$) to complex (what day of the week will be September 11, 3001?). This agent-dependent decision making is contrasted with the sorts of agent-centered and “adaptive” decisions that occur in real life. This agent-centered decision ranges from simple (e.g., choosing from a restaurant menu) to decisions that will impact the agent’s life (e.g., career decisions). For these agent-centered decisions, the dichotomous “true–false” metric does not apply because asserting that salad is an intrinsically correct choice and soup is an intrinsically false choice is self-refuting. Of course, this also holds for life decisions like the assertion that a doctoral degree in “clinical neuropsychology” is an intrinsically correct choice and one in “engineering” is an intrinsically false choice (Goldberg et al. 2012).

While this distinction is often underemphasized in clinical neuropsychology, it is central to understanding the nature of the patient’s decision making. This is especially true when making decisions about a patient’s competency for making cardinal decisions—such decisions are agent-centered, while veridical cognition serves a supportive role. Unfortunately, the vast majority of cognitive paradigms used in neuropsychological assessment are notoriously devoid of appropriate tools to study “agent-centered” cognition. Much of this is due to the traditional focus on assessment of veridical aspects of cognition in highly contrived, artificial, laboratory situations. This explains why many purported cognitive measures have notoriously poor ecological validity and why patients with prefrontal lesions have real-life problems even though they do well on neuropsychological tests purported to assess prefrontal functions (Sbordone 2010).

It is interesting to note that although cognitive neuroscience researchers have begun investigating various innovative paradigms that depart to various degrees

from the traditional “veridicality” approaches (Lieberman and Eisenberger 2005; Nakao et al. 2009, 2010, 2012); Paulus and Frank 2003; Johnson et al. 2005; Volz et al. 2006), very little of these developments are found in emerging clinical neuropsychology approaches. Instead, neuropsychologists tend to cling to outmoded paradigms (e.g., Wisconsin Card Sorting Test; Stroop Test) that are veridical in nature. In order to correct this situation, Goldberg argues for the creation of a new generation of cognitive paradigms that are devoid of the “true–false” metric and based on subjective preference. Goldberg has developed the cognitive bias test (CBT) as a nonveridical agent-centered assessment (Goldberg et al. 1994a, b, 1997; Goldberg and Podell 1999; Podell et al. 1995). The CBT is an inherently ambiguous, multiple-choice task in which the patient is presented with cards that have geometric designs on them. Each geometric design is categorized along five binary dimensions, which allows for a comparison in dimensional similarity between any two cards. After the examiner presents the patient with a target card, two choice cards are presented simultaneously in a vertical alignment below the target card. The patient is asked to look at the target card and then choose one of the two choice cards that the patient likes best. The two choice cards are characterized by different degrees of dimensional similarity to the target card. As a result, the subject must select the choice card that is more different from, or similar to the target card. Following 60 trials, the patient’s choice pattern is quantified. The CBT has two patterns of response: (1) The patient can respond in a highly context-dependent pattern in which the patient consistently chooses either the most different or the most similar choice card; or (2) The patient can respond in a context-invariant pattern in which the patient’s choice is not based on a consistent comparison to the target (i.e., disregard for context), but rather some subjective dimensional, sensory preference.

The inherent ambiguity of the CBT allows for a novel approach to ecological validity that assesses actor-centered, adaptive decision making that is based on an agent’s priorities. With the CBT, neuropsychologists have the first steps toward a future possible neuropsychological assessment that moves beyond a veridical, actor-independent decision making that requires a correct response intrinsic to the external situation. When contrasted with tests like the WCST that depend on veridical decision making, the CBT allows neuropsychologists to measure actor-centered decision making. Goldberg believes that the CBT better elucidates the functions of the frontal lobes and in a more ecologically valid way (Goldberg and Podell 1999, 2000).

6 Importance of Affective States for Cognitive Processing

Historically, much of psychology has been understood as comprising three related fields: cognition, affect, and motivation. Until recently, cognitive psychology has been the most extensively studied of the three, with affect and motivation being rather neglected. According to Baddeley (1981), the major reason for this is that

cognition can be studied relatively easily in the laboratory whereas affect and motivation require assessment of real-world activities. In recent years, cognitive neuropsychology has witnessed a resurgence of interest in (1) going beyond the artificial situation of the laboratory to assessments that reflect the everyday world (Neisser 1982); and (2) bringing together studies of cognition, emotion, and conation (Masmoudi et al. 2012). In fact, research on emotions is increasingly found in the literature: affective neuroscience (Adolphs et al. 2002; Ledoux 1996), neuroscience of psychopathology (Kohler et al. 2010), and clinical neuropsychology (Stuss and Levine 2002).

While the discussion of laboratory versus real-world assessment was discussed in the 1980s (see above), the latter issue of bringing together studies of cognition, emotion, and conation is something that is increasingly being discussed in terms of affective neuroscience (Panksepp 1998). Although the terms “cognition,” “motivation,” and “emotion” as important drivers for theory development and praxes in behavioral neuroscience research, the term “cognition” has been increasingly overused and misused since the cognitive revolution. According to Cromwell and Panksepp (2011), this has resulted in deficient development of a usable shared definition for the term “cognition.” They argue that this deficiency raises concerns about a possible misdirection of research within behavioral neuroscience. For Cromwell and Panksepp, the emphasis upon top-down (cortical → subcortical) perspectives tends to dominate the discussion in cognitive-guided research without concurrent noncognitive modes of bottom-up developmental thinking. They believe that this could hinder progress in understanding neurological and psychiatric disorders. As an alternative, they emphasize inclusion of bottom-up (subcortical → cortical) affective and motivational “state-control” perspectives. The affective neuroscience approach represents a more “embodied” organic view that accepts that cognitions are integrally linked to both our neurology as well as the environments in which we operate (Smith and Gasser 2005; Panksepp 2009, 2010).

The affective neuroscience critique that top-down perspectives tend to dominate the discussion in cognitive-guided research is readily applicable to the contemporary approach to neuropsychological assessment. Although cognitive-based understandings of brain–behavior relationships have grown in recent decades, the neuropsychological understandings of emotion remain poorly defined (Suchy 2011). While current approaches to neuropsychological assessment aide our understanding of cognitive conflict, everyday activities commonly come in the form of emotional distractors. Social and affective neuroscience studies have found that affective stimuli are particularly potent distractors that can reallocate processing resources and impair cognitive (e.g., attention) performance (Dolcos and McCarthy 2006; Pessoa 2008). Affective responses to emotional distractors may be understood as multimodal events in response to a stimulus that has particular significance for the participant, often signifying a potential threat or reward. Affective stimuli are particularly potent distractors that can reallocate processing resources and impact attentional performance (Dolcos and McCarthy 2006). Enhanced understanding of the effect of threatening stimuli upon executive functions has important implications for affective disorders (e.g., specific phobias, depression, and post-traumatic

stress disorder) that are characterized by increased susceptibility to affective distraction (Ellis and Ashbrook 1988; Wang et al. 2008). As one precondition for a specific affective experience, emotion may include automatic and controlled recognition and evaluation of a stimulus. In addition to the appraisal of a stimulus, affective reactions are characterized by psychophysiological changes (e.g., alterations in skin conductance and heart rate; as well as behavioral approach or avoidance) and involve a number of subcomponents occurring in frontal subcortical circuits (Bonelli and Cummings 2007; Pessoa 2009; Ray and Zald 2012).

According to models of neurovisceral integration, autonomic, attentional, and affective systems are simultaneously engaged in the support of self-regulation (Critchley 2005; Thayer and Lane 2000, 2009). Working from a neurovisceral integration model, Capuana et al. (2014) examined whether increase in difficulty of an executive-control task increases would increase the need for cardiac autonomic regulation in maintaining effective cognitive control. Results indicate that pretask respiratory sinus arrhythmia predicted accuracy best on a Stroop task when errors resulted in financial loss. Greater respiratory sinus arrhythmia has also been found when participants have had to execute correct responses more quickly in the context of an emotional Stroop task (Mathewson et al. 2010). Several studies using the classical Stroop paradigm have found performance-related reductions in heart rate and respiratory sinus arrhythmia (e.g., Boutcher and Boutcher 2006; Delaney and Brodie 2000; Waldstein et al. 1997; Wright et al. 2007). Another psychophysiological metric that has been found to increase as workload increases is skin conductance. During the Stroop task, incongruent stimuli, associated with a higher degree of task difficulty than congruent stimuli, has been found to elicit larger skin conductance responses (Kobayashi et al. 2007). Increased task difficulty using an n-back task also results in increased skin conductance levels (Mehler et al. 2009). Additionally, numerous studies using various cognitive tasks have evidenced increased heart rate associated with increased cognitive workload (e.g., Carroll et al. 1986; Kennedy and Scholey 2000; Mehler et al. 2009; Sloan et al. 1991). An increase in respiratory rate has been consistently associated with increased cognitive demand (e.g., Backs and Selijos 1994; Brookings et al. 1996; Mehler et al. 2009).

Models of affective–cognitive interactions reveal two cortical–subcortical networks that play vital and dissociable roles in human emotion and cognition (Dolcos and McCarthy 2006). In a functional connectivity magnetic resonance imaging study, Seeley et al. (2007) identified these two cortical–subcortical networks as follows: (1) an “executive-control network” that links dorsolateral frontal and parietal neocortices; and (2) a “salience network” anchored by dorsal anterior cingulate (dACC) and orbital frontoinsula cortices with robust connectivity to subcortical and limbic structures. The “executive-control network” reflects brain regions and processes associated with active maintenance of goal-relevant behavior. The “salience network” includes brain regions and processes typically associated with affective processing. While the executive-control network is frequently coactivated with the salience network in tasks of attention, working memory, and response selection, the salience network also activates in response to threats.

Increased arousal may impact the processing of salient information and enhance the contrast between stimuli with different levels of salience (Critchley 2005).

The distinction of cognitive processes in this dual pathway approach has similarities to a neuropsychological subdivision of cognitive control (Zelazo et al. 2003). Zelazo et al. (2003) differentiate between “cold” cognitive control (the executive dysfunction pathway) and “hot” affective aspects of cognitive control (the motivational dysfunction pathway). In a similar fashion, Nigg (2000, 2001) distinguishes between behavioral inhibition (i.e., response inhibition) and motivational inhibition (i.e., personality and motivation). In Sonuga-Barke’s (2003) neuropsychological research, these different aspects of inhibition have been shown to be related to different brain networks. The distinction between “cold” cognitive reasoning and “hot” affective processing has been studied in decision neuroscience. While “cold” cognitive processing tends to be relatively logic-based and free from much affective arousal, “hot” affective processing occurs in the face of reward and punishment, self-regulation, and decision making involving personal interpretation (Ardila 2008; Brock et al. 2009; Chan et al. 2008; Grafman and Litvan 1999; Happaney et al. 2004; Seguin et al. 2007). A number of studies have found that impairments in either the “cold” or “hot” cognitive functions may be related to deficits in everyday functioning (e.g., independence at home, ability to work, school attendance, and social relations (Goel et al. 1997; Grafman et al. 1996; Green 1996; Green et al. 2000; see Chan et al. 2008 for review).

The idea of “hot” decision making is consistent with the somatic marker hypothesis (Bechara 2004; Bechara and Damasio 2005; Bechara et al. 1997, 1998; Damasio 1996). Damasio (1994, 1996) suggested a somatic marker hypothesis approach to decision making, in which the experience of an emotion (e.g., “gut feeling” and “hunch”) results in a “somatic marker” that guides decision making. According to Damasio (1994), the somatic marker is hypothesized to play a role in “hot” decision making in that it assists the “cold” decision making process by biasing the available response selections in a complex decision making task. According to the somatic marker hypothesis, when persons are faced with decisions, they experience somatic sensations (i.e., somatic markers) that occur in advance of real consequences of possible different alternatives (Bechara et al. 1997). These somatic markers act as affective catalysts for decision making, in which distinct alternatives are evaluated via somatic sensations that guide adaptive decision making (Damasio 1996). The ventromedial prefrontal cortex (VMPFC) and its limbic system connections are considered key structures in the somatic marker hypothesis and the decision making process (Bechara et al. 1997, 1998). However, the neuropsychological assessment of the VMPFC remains somewhat enigmatic as patients tend to have both an appearance of normality on most neuropsychological tests and also problems in their everyday lives (Zald and Andreotti 2010).

The somatic marker hypothesis was originally proposed to account for a subgroup of patients with VMPFC (i.e., orbitofrontal) lesions who appeared to have intact cognitive processing, but had lost the capacity to make appropriate life decisions. According to Damasio (1994), they had lost the ability to weigh the positive and negative features of decision-based outcomes. The Iowa gambling task

(IGT; Bechara et al. 1994; Bechara 2007) was developed to assess these patients and is increasingly being accepted as a neuropsychological measure of affect-based decision making (Bowman et al. 2005). The IGT is a computerized assessment of reward-related decision making that measures temporal foresight and risky decision making (Bechara et al. 1994; Bechara 2007). During IGT assessment, the patient is instructed to choose cards from four decks (A–D). Selection of each card results in on-screen feedback regarding either a “gain” or “loss” of currency. In the four decks, there are two advantageous (C and D) decks that result in money gained (\$250 every 10 cards) and low monetary loss during the trial. The other two decks (A and B) are disadvantageous and involve greater wins (around \$100 each card) than C and D (around \$50) but also incur greater losses, meaning that one loses \$250 every 10 cards in Decks A and B. The primary dependent variables derived from the IGT are total score and net score $[(C + D) - (A + B)]$ and block score $[(C + D) - (A + B)]$ for each segment or block of 20 cards, frequency of deck choices, and spared or impaired performance according to a cutoff point of -10 (Bechara et al. 2000) especially in brain-damaged subjects.

Neuroimaging studies of persons performing the IGT have revealed activation in the orbitofrontal cortex (Ernst et al. 2002; Grant et al. 1999; Windmann et al. 2006), which appears to be significant for signaling the anticipated rewards/punishments of an action and for adaptive learning (Schoenbaum et al. 2011). Evidence for the somatic marker hypothesis’s role in hot decision making over IGT trials can be found in the demonstration of an anticipatory electrodermal response in healthy controls to card selection (Bechara et al. 1996, 1997). For example, prior to selecting a card from a risky deck, a healthy control will show a physiological reaction indicating that the participant is experiencing bodily the anticipated risk. Further, studies have shown that damage to vmPFC (part of the orbitofrontal cortex) and the amygdala prevents the use of somatic (affective) signals for advantageous decision making (Bechara et al. 1996, 1998; Bechara et al. 2000). It is noteworthy that there are different roles played by the ventromedial prefrontal cortex (vmPFC) and amygdala in decision making. While vmPFC patients were able to generate electrodermal responses when they received a reward or a punishment, amygdala patients failed to do so (Bechara et al. 1999). These findings have been supported in other that have found positive correlations between the development of anticipatory skin conductance responses and better performance on a similar gambling task (Crone et al. 2004; Carter and Pasqualini 2004).

It is important to note that alternative explanations of Bechara’s findings have been posited. Tomb et al. (2002) suggested that the anticipatory responses are related to the belief that the risky choice will probably produce a large reward—higher immediate short-term benefits of the risky decks (\$100 versus \$50). According to Tomb et al. (2002), the anticipatory SCR effect is unrelated to any long-term somatic marker mechanism. Nevertheless, Tomb et al.’s (2002) account does not readily explain deficient performance in ventromedial PFC patients. While these patients fail to develop an anticipatory response to the decks with immediate short-term benefits, they also prefer these decks throughout the task (Clark and Manes 2004).

While the IGT may have potential for assessment of “hot” affective processing (Baddeley 2011), there have been failures to replicate the initial studies (Hinson et al. 2002, 2003). Whereas data from Bechara et al.’s (1998) early studies suggested normal performance of patients with dorsolateral prefrontal lesions, a number of later studies indicate significant effects of lesions that include either dorsolateral or dorsomedial prefrontal cortex regions (Manes et al. 2002; Clark et al. 2003). Further, researchers have argued that the IGT is deficient for understanding the affective impact of emotional stimuli upon cognitive processing because (1) the observed effects on the IGT may simply be cognitive (not affective) demands placed resulting from such a complex decision task (Hinson et al. 2002, 2003); and (2) the IGT is more of a learning task (Baddeley 2011), whereas a true assessment of affective impact upon cognitive processing requires a measure of the capacity to evaluate existing valences (i.e., positive, negative, and neutral). In a similar manner, Fellows and Farah (2005) have suggested that an elemental deficit in reversal learning (instead of deficit in decision making) may better explain the VMPFC lesion patients’ selections of disadvantageous and risky cards on the IGT. Evidence for this is indicated by improved performance when the initial bias favoring the disadvantageous decks is removed by reordering the cards. Hence, while insensitivity to risk is often used to explain poor performance on the IGT, the learning and explicit reversal components of the IGT may better explain into what the IGT it is actually tapping. Further, like other cognitive measures, the IGT was created to assess the construct of decision making in a laboratory setting, but it remains to be seen whether a relation between performance on the IGT and real-world decision making exists (Buelow and Suhr 2009).

7 Conclusions

In summary, the past twenty years in neuropsychology we have seen a shift in assessment from lesion localization to assessment of everyday functioning. Clinical neuropsychologists are increasingly being asked to make prescriptive statements about everyday functioning. This new role for neuropsychologists has resulted in increased emphasis upon the ecological validity of neuropsychological instruments. As a result, neuropsychologists have been experiencing a need to move beyond the limited generalizability of results found in many earlier developed neuropsychology batteries to measures that more closely approximate real-world function. However, neuropsychologists have been slow to establish tests that will address assessment of everyday functioning. Part of the delay has resulted from a lack of clear consensus on what constitutes an ecologically valid assessment.

In addition to these historical issues and emerging definitions for ecological validity in neuropsychological assessments, there is a growing desire for “ecological validity” to be need more than simple cosmetic changes to represent real-life situations. Instead, there is a more fundamental issue that the majority of neuropsychological assessments focus upon various aspects of veridical constructs and

neglect the reality that real-life veridical decision making is merely a tool subordinate to adaptive decision making. A recent focusing of the discussion by Burgess and colleagues (2006) emphasizes the need for “function-led approaches” to neuropsychological models and assessments. While these approaches have been gaining in popularity, there are a number of unfortunate limitations that are apparent in the obvious drawbacks to experiments conducted in real-life settings. Function-led neuropsychological assessments can be time-consuming, require transportation, involve consent from local businesses, costly, and difficult to replicate or standardize across settings. Further, there are times when function-led assessments in real-world settings are not feasible for participants with significant behavioral, psychiatric, or mobility difficulties. There is also a growing interest in the interplay of “cold” cognitive processing (linked to dorsal and lateral regions of the prefrontal cortex) of relatively abstract, context-free information, and “hot” cognitive processing (linked to the functioning of the orbitofrontal cortex) involved when emotionally laden information is present. Unfortunately, very little has been done to include affective components into the neuropsychological assessment.

In the chapters that follow, **there will be review of these issues for each of three waves found in theoretical formulations of neuropsychological assessment.** Throughout, there will be emphasis upon the ways in which both paper-and-pencil and computer-automated neuropsychological assessments reflect “construct-driven” and “function-led” approaches to neuropsychological assessment. A preference is emphasized for “function-led” approaches to models and assessments that proceed backward from a directly observable everyday behavior to measure the ways in which a set of actions lead to a given behavior in normal and disrupted processing. Further, there is discussion of the potential for improving our understanding of ecological validity via the inclusion of the interplay of “cold” cognitive processing of relatively abstract, context-free information, and “hot” cognitive processing involved when emotionally laden information.

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