



2 Real-world Consequences of Social Deficits:
 3 Executive Functions, Social Competences,
 4 and Theory of Mind in Patients with Ventral
 5 Frontal Damage and Traumatic Brain Injury

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7 **Abstract**

8 A variety of brain disorders may give rise to social deficits. Social neuroscience is in a position to help
 9 such patients by providing objective methods of defining and measuring social competencies. Such
 10 measurements can provide researchers with a more detailed picture of the components of social
 11 competencies, assist clinicians in making appropriate treatment recommendations, and provide a
 12 foundation for further research into rehabilitation programs tailored to remediating specific and
 13 well-defined social difficulties. This chapter reviews existing tools for measuring social competencies,
 14 and examines the relationships between these tools and measures of executive functions. In doing so,
 15 it discusses the need for more precise use of the terms “executive functions” and “theory of mind.”

16 **Keywords:** traumatic brain injury, frontal lobes, ventral frontal cortex, orbitofrontal cortex, theory
 17 of mind, social competence, social skills, executive functioning, executive function, neuropsychological
 18 assessment

19 **Introduction**

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 21 deficits. Social neuroscience is in a position to help
 22 such patients by providing objective methods of
 23 defining and measuring social competencies. Such
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 25 detailed picture of the components of social compe-
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 30 difficulties. In this chapter, we review existing tools
 31 for measuring social competencies, and examine the

relationships between these tools and measures of 32
 executive functions. In doing so, we discuss the 33
 need for more precise use of the terms “executive 34
 functions” and “theory of mind.” Because neither 35
 refers to a unitary underlying function, we encour- 36
 age researchers to link the use of these terms to spe- 37
 cific tests or sub-processes, to avoid conflation of 38
 separable processes. We review several measures of 39
 social competence, focusing on tests of the ability to 40
 infer others’ internal, mental states. The chapter 41
 focuses on how these measures have been used with 42
 patients who have nonpenetrating traumatic brain 43
 injuries (TBI) and/or damage to the ventral frontal 44



1 cortex, because they are the largest group of patients
2 with acquired brain damage who present with social
3 deficits (Langlois, Rutland-Brown, & Wald, 2006).
4 We find that only Sarcasm/Irony Detection tasks,
5 the Recognition of Faux Pas Task, and The Awareness
6 of Social Inference Test (TASIT) reliably differenti-
7 ate these patients from healthy matched controls,
8 and correlate with patients' real-world outcomes.
9 Current clinical practice assesses patients with ven-
10 tral frontal damage and TBI with objective, perfor-
11 mance-based measures of *cognitive* abilities, whereas
12 *social* competencies are often assessed with question-
13 naires or qualitative observations. We encourage
14 social neuroscientists to work with neuropsycholo-
15 gists and neurologists to bring objective assessments
16 of a wide range of social competencies into the
17 clinic, where they can guide rehabilitation, and
18 improve patients' and their loved ones' lives.

19 Background

20 As a society, we recognize that someone with a
21 stroke affecting her motor cortex cannot help the
22 fact that she cannot move one side of her body. We
23 recognize that someone with Alzheimer's disease
24 cannot help the fact that he cannot remember who
25 came to visit this morning. With social deficits,
26 however, our society tends not to recognize that
27 some people with neurological damage might have
28 difficulty reading social cues, inhibiting impulses, or
29 being aware of how their social behavior is inappro-
30 priate. The general attitude still seems to be that
31 someone who is socially inappropriate has a per-
32 sonal or moral failing.

33 There is little public education to broadcast a cen-
34 tral insight of social neuroscience: Deficits in social
35 behavior can have a neurological origin because parts
36 of the brain are specialized for processing social and
37 emotional information. Those parts of the brain
38 have been called "the social brain" by social neuro-
39 scientists, and include frontal and temporal areas
40 (Brothers, 1990). The lay public does not necessar-
41 ily know about the existence of specialized systems
42 in the brain for social information-processing.
43 When brain injury is called "a hidden disability"
44 (e.g., Abouhamad, 1999)), one meaning of that
45 phrase is that people cannot see the source of some-
46 one's inappropriate behavior, that they cannot see
47 that the person now has tremendous difficulty con-
48 trolling impulses, and accurately perceiving social
49 cues. People, even family members and friends,
50 get angry, offended, and may reject the person with
51 a brain injury because they misunderstand the
52 behavior's source. Such social consequences have

53 profound and potentially long-term effects on
54 patients' quality of life (Langlois et al., 2006;
55 McDonald, Flanagan, Rollins, & Kinch, 2003;
56 Ownsworth & Fleming, 2005; Ponsford, Draper,
57 & Schonberger, 2008). Given that some neurologi-
58 cal patients have significant deficits in social judg-
59 ment and in producing appropriate social behavior,
60 it is imperative that social neuroscientists discuss
61 and measure the real-world consequences of damage
62 to the social brain, and devise and publicize new
63 tools for assessing problems with social competen-
64 cies objectively. Social neuroscience must be science
65 in the public interest.

66 What is Needed to Assess Patients 67 with Social Deficits?

68 A variety of brain disorders may give rise to social
69 deficits: traumatic brain injury (e.g., Langlois et al.,
70 2006), damage to the amygdala (e.g., Brothers,
71 Ring, & Kling, 1990; Broks et al., 1998; Adolphs,
72 Tranel, & Damasio, 1998; Stone, Baron-Cohen,
73 Calder, Keane, & Young, 2003), damage to the
74 frontal cortex from trauma, surgery, stroke, or front-
75 otemporal dementia (e.g., Stone, 2000; Neary,
76 1999; Tekin & Cummings, 2002), damage to the
77 cerebellum (e.g., Shevell & Majnemer, 1996;
78 Ozonoff, Williams, Gale, & Miller, 1999), or
79 damage to the temporal lobes (Brothers, 1990;
80 Rosen et al., 2002; Park et al., 2003). The largest
81 group of people who are at risk for social and emo-
82 tional problems is the group suffering nonpenetrat-
83 ing traumatic brain injuries (TBI; Langlois et al.,
84 2006), causing damage predominantly in the ven-
85 tral frontal and anterior temporal regions (e.g.,
86 Devinsky & D'Esposito, 2004; Levine et al., 2008).
87 Accordingly, here we focus specifically on people
88 with damage to the ventral frontal cortex, also called
89 the orbitofrontal cortex, and people with TBI,
90 including those with focal damage to the ventral
91 frontal cortex. (See Figure 31.1 for diagram of fron-
92 tal cortex.) The two groups of patients overlap, but
93 are not exactly the same. In many research studies
94 of patients with ventral frontal damage, the most
95 common cause of damage is traumatic brain injury,
96 though some patients may have damage from sur-
97 gery for tumors, or other sources. (The term "ven-
98 tromedial frontal damage" means lesions that affect
99 *both* the ventral frontal cortex and medial frontal
100 cortex, —often caused by removal of a tumor. See
101 Figure 31.1.) As noted above, particularly in moder-
102 ate to severe TBI, damage to the ventral frontal
103 cortex is one of the most common lesion locations.
104 Studies examining the physics of TBI have shown

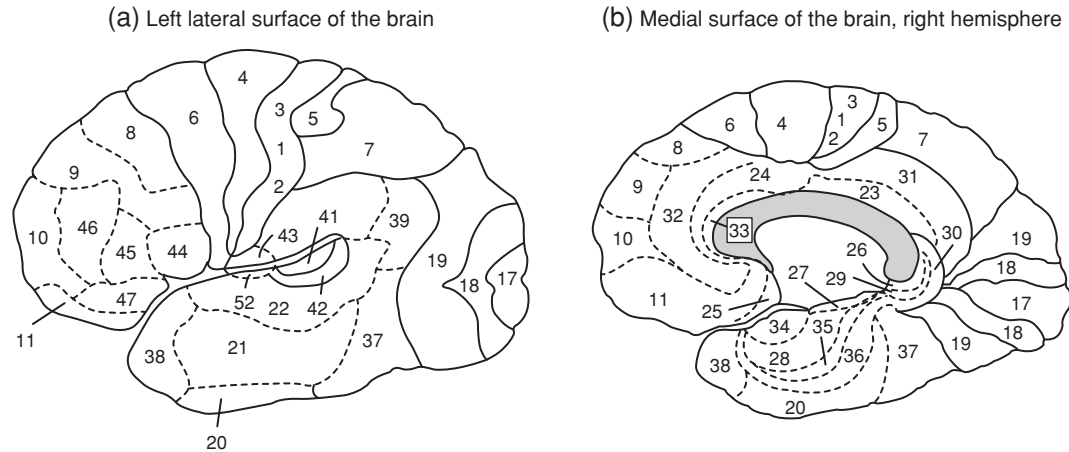


Fig. 31.1 The brain, with Brodmann areas marked (anatomical regions determined by differences in cell structure). (a) View of the left hemisphere from the outside (lateral view). Ventral frontal cortex in this view would include primarily Brodmann area 11, but also area 47 and ventral parts of area 10. Dorsolateral prefrontal cortex would include areas 6, 8, 9, and dorsal parts of 10 & 46. (b) View of the right hemisphere from the center of the brain (medial view). Ventral frontal cortex would include Brodmann areas 11, 25 and possibly ventral parts of area 32. Medial frontal cortex would include areas 24, 32, and area 33 (anterior cingulate cortex). Dorsolateral prefrontal cortex would include areas 6, 8, 9 on this medial view.

1 that the frontal lobes exhibit the most deformation
 2 by being compressed forward against the skull,
 3 whereas more posterior regions exhibit stretching,
 4 which shears fiber pathways (Bayly et al., 2005).
 5 Furthermore, as the brain bounces around inside
 6 the skull following a severe blow, the bony protrusions
 7 in the skull above the eyes, directly below the
 8 ventral frontal cortex, can bruise and tear neural
 9 tissue, causing focal lesions.

10 Patients with TBI also have diffuse axonal injury
 11 because of stretching and shearing of axons and
 12 toxic chemical events started by the trauma that
 13 unfold for hours or days after the injury (e.g., Kraus
 14 et al., 2007; McCrea, 2007; Kumar et al., 2009).
 15 Thus, while people with TBI are at high risk for ventral
 16 frontal dysfunction, they are also likely to have
 17 difficulties from multiple diffuse injuries affecting
 18 various brain regions, potentially leading to several
 19 sources of deficits in social competencies and cognition.
 20 Therefore, when we say, below, “patients with
 21 ventral frontal cortex damage and/or TBI,” these
 22 two groups should be understood as overlapping
 23 but not identical.

24 Social deficits may result from impairments in
 25 multiple cognitive and affective systems, and as yet,
 26 we do not have a precise model of all of the systems
 27 underlying social behavior. Social neuroscience is
 28 a new and burgeoning field for this precise reason:
 29 there is much to discover about how the social brain
 30 works. Defining social information-processing rigorously
 31 is a difficult problem, because so many

32 processes are involved. For example, patients with
 33 ventral frontal damage may suffer from both a difficulty
 34 reading other people’s emotional expressions (Hornak, et al., 2003; Hornak, Rolls, & Wade,
 35 1996) and a difficulty inhibiting inappropriate
 36 remarks in a particular social context (Berlin, Rolls,
 37 & Kischka, 2004; Cummings, 1993; Kim, 2002).
 38 Although both of these difficulties can be categorized
 39 as deficits in the *social* realm, they may result
 40 from impairments in different underlying systems,
 41 and would entail different types of treatment. In
 42 order to get a full picture of the many factors that
 43 may influence inappropriate social behavior, clinicians
 44 need to assess cognitive *and* social functions. 45

46 Psychological assessments can use any of four
 47 methods to evaluate a patient’s competence in a
 48 particular domain. First, performance measures are
 49 objective tests requiring patients to demonstrate
 50 competence by solving a problem in that domain.
 51 Second, informant reports are questionnaires given
 52 to caregivers to report on patients’ competence.
 53 Third, self-reports are questionnaires given to
 54 patients to report on their own competence, or are
 55 patients’ own unstructured, qualitative reports of
 56 their experiences. Fourth, clinicians use their own
 57 qualitative judgments, or those produced by family
 58 and friends to assess certain behaviors.

59 All four of these methods have value. Some phenomena,
 60 such as emotional distress, are inherently subjective,
 61 internal experiences, making a self-report necessary
 62 to gather this information. Other behaviors,

1 such as easily losing one's temper, may not occur in
2 the presence of strangers or in formal settings,
3 making the behaviors difficult to observe in the
4 clinic or laboratory. Reports about patients' behav-
5 iors in multiple settings are a rich source of informa-
6 tion, and should continue to be part of assessments
7 of social and emotional problems. Nevertheless,
8 objective, performance-based measures can more
9 precisely describe particular abilities: for instance,
10 does socially inappropriate behavior result from a
11 problem with eye contact, interpreting facial expres-
12 sions, or making inferences about others' intentions?
13 A clinician's qualitative report about a patient's cog-
14 nitive abilities such as "the patient seemed bright
15 and solved everyday problems without too much
16 effort" is not taken seriously *by itself* as an assess-
17 ment of cognition; however, a qualitative report
18 such as "the client was often socially inappropriate
19 and made offensive remarks" is often taken more
20 seriously. We would like to see an increase in the use
21 of performance measures to assess social and emo-
22 tional abilities, in order to increase the objectivity
23 and utility of these assessments.

24 Social neuroscience has advanced enough in the
25 last decade to be able to provide clinicians with
26 performance measures of several social and emo-
27 tional competencies: facial expression recognition,
28 empathy, theory of mind, eye-gaze tracking, emo-
29 tion regulation, understanding and using language
30 pragmatics. Many of these measures have been used
31 in the experimental literature more than in the clin-
32 ical literature, and therefore not all measures have
33 population norms gathered in large samples, but
34 there are enough useful social competence tasks for
35 researchers to begin collecting norms. We will
36 review some of these new tasks in this chapter, and
37 recommend some directions for research.

38 **The Interaction of Executive Functions** 39 **and Social Competencies**

40 Social interaction is cognitively complex and requires
41 multitasking, applying memories to a changing
42 stream of behavior, tracking changes in social con-
43 text and rewards, selecting behaviors from a range of
44 options, and rapidly changing the focus of attention.
45 Such situations make high demands on executive
46 functions, a group of cognitive abilities including
47 working memory, distraction-suppression, plan-
48 ning, problem-solving and the organization of
49 behavioral output. Functional neuroimaging has
50 revealed that tests of executive functions are associ-
51 ated primarily with activation in dorsolateral frontal
52 regions (e.g., Derrfuss, 2005), rather than ventral

53 frontal regions. (See Figure 31.1 for a diagram of
54 ventral frontal and dorsolateral frontal regions.)

55 Deficits in executive abilities can cause problems
56 in social interaction, just as they do in other com-
57 plex tasks. Imagine a common social situation:
58 a group of people are standing together at a party,
59 talking. One man tells a political joke, and while
60 some people in the group laugh, a couple of people
61 frown in disapproval, and an awkward moment
62 ensues. A socially skilled person in the group then
63 changes the topic to something politically neutral.
64 Suppose one woman in the group has a deficit in
65 executive functioning, specifically, a deficit in the
66 ability to shift her attention flexibly. She might con-
67 tinue to focus on the man who told the joke, with-
68 out shifting her attention to the reactions of the
69 others in the group. She might be puzzled by the
70 change in conversational topic, or might tell another
71 political joke, having missed important social infor-
72 mation by not attending to it. An attentional deficit
73 is not specifically social, but, as seen in this example,
74 it can cause social problems. To predict social out-
75 comes for neurological patients with social behavior
76 difficulties, therefore, a clinician will need to assess
77 executive functions thoroughly.

78 Although it is *necessary* to assess executive func-
79 tions in people with social deficits caused by neuro-
80 logical damage, it is not *sufficient*. Clinicians must
81 also assess social competencies *per se* to provide the
82 best information to patients and their families about
83 the difficulties they are likely to encounter, and to
84 provide detailed recommendations for rehabilita-
85 tion. Certain social competencies might be com-
86 pletely independent of certain executive abilities.
87 Impaired recognition of emotion from facial expres-
88 sions or voice, or the ability to tell if someone might
89 be cheating in a deal can cause social difficulties
90 even if some executive functions are intact (Stone
91 et al., 2002; Hornak et al., 1996). Researchers have
92 described patients with focal lesions to ventral fron-
93 tal regions resulting in social dysfunction, but
94 who have some spared executive abilities (e.g.,
95 Eslinger & Damasio, 1985; Dimitrov, Phipps,
96 Zahn, & Grafman, 1999; Stone et al., 2002). (The
97 assessments of executive functions in these patients
98 were not exhaustive, and thus some executive defi-
99 cits may have been missed.) Social and executive
100 skills have also been dissociated in patients with
101 the frontal variant of fronto-temporal dementia,
102 a progressive disease first causing atrophy in the
103 ventral frontal cortex. Such patients present with
104 personality changes and social and emotional dis-
105 ruptions, but generally normal performance on

1 some commonly used tests of executive functions
2 (Gregory, 1999; Lough, Gregory, & Hodges, 2001).
3 Finally, performance on some executive tests does
4 not predict social performance in people with TBI
5 (Milders, Fuchs, & Crawford, 2003). Thus, there
6 is mounting evidence that social and executive
7 functioning are at least partly independent of one
8 another.

9 *The Nature of Executive Functions* 10 *and the Most Effective Measures*

11 Part of the confusion about executive functions out-
12 lined here comes from a tendency in many neuropsy-
13 chological studies to assess what they call “executive
14 function” (singular), referring to the “function” as if
15 it were the same ability tapped by different tests
16 (e.g., Bach, Happé, Fleming, & Powell, 2000;
17 Lough et al., 2001; McPherson, Fairbanks, Tiken,
18 Cummings, & Back-Madruga, 2002; Weyandt,
19 2005). However, the many different tasks used to
20 assess executive functions do not all necessarily inter-
21 correlate and do not all measure the same thing.
22 Thus, “executive function” (singular) is a problem-
23 atic term because it does not refer to a unitary abil-
24 ity, but rather to a *set* of cognitive abilities. The term
25 was originally introduced to refer to the “central
26 executive,” the controller of the short-term memory
27 system, which allocates attentional resources, and
28 off-loads some processing demands to its “slave sys-
29 tems,” the articulatory loop and the visuospatial
30 sketch pad (Baddeley, 1981). Since then, “executive
31 functions” has come to mean a collection of cogni-
32 tive abilities, usually including working memory,
33 sequencing, planning, set-shifting, cognitive flexi-
34 bility, flexible control of attention, task-switching,
35 establishing a hierarchy of goals, inhibition of com-
36 peting action programs or cognitive processes,
37 response inhibition and selection, and the applica-
38 tion of strategic behavior. Tests of these various
39 abilities are by no means interchangeable.

40 No one truly claims that there is a unitary “exec-
41 utive function”; it is rather that the term has come
42 to be used as if there were. In fact, factor analyses do
43 not show a unitary factor structure for different tests
44 of executive functions (Pennington, 1997, Burgess,
45 Alderman, Evans, Emslie, & Wilson, 1998; Miyake,
46 Friedman, Emerson, Witzki, & Howerter, 2000;
47 Busch, McBride, Curtiss, & Vanderploeg, 2005).
48 Furthermore, because the results of any given factor
49 analysis of executive functions depend on which
50 particular cognitive tests are included in the analy-
51 sis, there can be no definitive factor analysis of exec-
52 utive functions. Also, the way that factors from the

53 analyses are named may vary from one research
54 group to another. Nevertheless, there is some over-
55 lap in the factors discovered for executive functions.
56 Pennington (1997) analyzed executive functions in
57 a group of typically developing children and chil-
58 dren with developmental disorders, and found three
59 factors that were consistent across both groups:
60 1) working memory, 2) flexibility/set-shifting, and
61 3) motor inhibition. Researchers using somewhat
62 different tests report a slightly different three-factor
63 solution: 1) information updating and monitoring,
64 2) set shifting, and 3) inhibition (Miyake et al.,
65 2000). In a large sample of patients with TBI, Busch
66 and colleagues (2005) also found three factors:
67 1) cognitive control, particularly of material in
68 working memory; 2) higher-order executive func-
69 tions including both self-generative behavior and
70 cognitive flexibility/set shifting; and 3) error control
71 failures, especially of inhibition of errors. There are
72 clear similarities in the contents of the three sets
73 of three-factor accounts of executive functions.
74 Others, however, have suggested a five-factor struc-
75 ture for executive functions, including 1) inhibition
76 (the ability to suppress a prepotent response);
77 2) planning (goal-directed planning and execution
78 of behavior, which includes insight); 3) memory
79 organization (temporal sequencing of memory);
80 and 4) positive and 5) negative personality changes
81 that co-occur with the cognitive syndrome (Burgess,
82 et al., 1998). Still others have argued that executive
83 functions can be reduced to working memory, and
84 that compromised working memory affects all exec-
85 utive functions (Braver, Cohen, & Barch, 2002;
86 Miller, 2007).

87 Some of the same researchers who have investi-
88 gated the factor structure of executive functions
89 have argued that the original theoretical formula-
90 tion of executive functions is no longer clinically
91 useful, and that a new set of tests ought to be devel-
92 oped that are focused on functional evaluations and
93 ecological validity (Burgess et al., 2006). We agree,
94 and encourage, at the very least, the use of the
95 plural w“executive functions,” to denote the multi-
96 plicity of cognitive processes that the concept com-
97 prises. We would also like to suggest that authors
98 always describe the specific task or function that is
99 implicated in the assessment of executive functions,
100 to add clarity to both research and clinical interpre-
101 tations. Rather than saying, for example, “executive
102 function was correlated with patients’ behavioral
103 problems,” a more specific statement such as “perse-
104 verative errors on the Wisconsin Card Sorting
105 Test were correlated with patients’ scores on the

1 Neuropsychiatric Index” would be both more accu- 27
 2 rate and more useful, and would reduce some of the 28
 3 conceptual confusion in the executive functioning 29
 4 literature. Finally, because of the plurality of cog- 30
 5 nitive abilities summed up by the term “executive 31
 6 functions,” clinicians should use multiple tests to 32
 7 assess these multiple abilities (Gioia & Isquith, 33
 8 2004).

9 **Assessments of Executive Functions**
 10 **in Patients with Ventral Frontal**
 11 **Damage and TBI**

12 *Common Tests*

13 Commonly used tests of executive functions include
 14 the Trail Making Test, Parts A & B, a test of sequenc-
 15 ing and working memory (e.g., Reitan, 1958);
 16 verbal fluency tests, such as F-A-S or semantic flu-
 17 ency (e.g., Benton & Hamsher, 1989); nonverbal
 18 design fluency tests (e.g., the Design Fluency sub-
 19 test of the Delis-Kaplan Executive Function System
 20 (D-KEFS)); the Stroop color-word interference test,
 21 a test of cognitive inhibition (e.g., Stroop, 1935);
 22 cognitive estimates tasks, measuring ability to esti-
 23 mate without strong external cues (e.g., Shallice
 24 & Evans, 1978); the Wisconsin Card Sorting Test
 25 (WCST) or the California Card Sorting Test,
 26 measuring several abilities, including set-shifting

(e.g., Berg, 1948; Milner, 1964; Delis, Kaplan,
 & Kramer, 2001); the Tower of London (e.g.,
 Culbertson & Zillmer, 2001) and the Tower of Hanoi
 (e.g., Samet & Marshall-Mies, 1987), measuring
 sequencing and planning, Go/No-go tasks, measur-
 ing inhibition (e.g., Robertson, Manly, Andrade,
 Baddeley, & Yiend, 1997); and the Hayling Sentence
 Completion Test, measuring inhibition (Burgess &
 Shallice, 1997). There are also batteries, such as the
 Delis-Kaplan Executive Function Battery (D-KEFS;
 Delis et al., 2001), which contain a number of these
 tasks as subtests. Among these performance-based
 measures of frontal lobe functions, each task has dif-
 ferent strengths and weaknesses (see Table 31.1).

41 *Available norms on tests*

42 Appropriate normative data that are stratified by age
 43 and education are available for Trail Making (Strauss
 et al., 2006), Verbal Fluency (Strauss, Sherman, &
 Spreen, 2006), and Card Sorting tests (Heaton,
 Chelune, Talley, Kay, & Curtiss, 1993; Delis et al.,
 2001). Norms stratified by age alone are avail-
 47 able for the Stroop (e.g., Delis et al., 2001) and
 48 Tower Tests (Delis et al., 2001; Culbertson &
 49 Zillmer, 2001). Unstratified norms are available for
 50 Go/No-go (Dubois, Slachevsky, Litvan, & Pillon,
 51 2000) and the Hayling Sentence Completion tests
 52

Table 31.1 Comparison of Commonly Used Tests of Executive Functions

Neuropsychological Test	Normative Data Stratified By	Neuroanatomical Correlates	Links to Functional Outcome
Trail Making Test	Age, Education	Dorsolateral prefrontal cortex	Activities of Daily Living
Verbal Fluency	Age, Education	Frontal, temporal, parietal lobes	Activities of Daily Living
Stroop Test	Age	Dorsolateral and dorsomedial prefrontal cortex	Treatment Outcome Measures*
Card Sorting Tests	Age, Education	Dorsolateral prefrontal and parietal cortices	Need for Supervision, Functional Status at Hospital Discharge
Hayling Sentence Completion	Unstratified Separate norms for older adults	Frontal lobes	Caregiver Questionnaire of Functional Outcome
Tower Tests	Age	Frontal and parietal lobes.	None
Behavioral Assessment of Dysexecutive Function	Unstratified, No Scaled Scores for Subtests	Non-specific Brain Damage	+ Caregiver Questionnaire of Functional Outcome
Go/No Go Test	Unstratified	Ventral prefrontal cortex	Everyday Action Slips

Summary of neuropsychological tests of frontal lobe function in terms of the availability of appropriate norms, neuro-anatomical correlates of task performance, and correlations with measures of functional outcome. * in Modified versions of the Stroop Task; + inconsistent finding.

1 (Burgess & Shallice, 1997). For the Hayling, norms
2 have been collected separately for older adults
3 (Bielak et al., 2006). For cognitive estimates tests,
4 norms for adults (Axelrod & Millis, 1994) and older
5 adults (Gillespie, Evans, Gardener, & Bowen, 2002)
6 are available.

7 *Brain regions involved in tests*

8 Not all of the tests have specific neuroanatomical
9 correlates, and not all are sensitive to TBI or ventral
10 frontal damage. There is evidence indicating no
11 specific association between frontal damage and
12 performance on cognitive estimates tests (Taylor &
13 O'Carroll, 1995). Tower tests and card sorting tests
14 have frontal *and* parietal lobe involvement, and
15 verbal fluency tests are associated with broad net-
16 works including the frontal, temporal and parietal
17 lobes (e.g., Baldo, Schwartz, Wilkins, & Dronkers,
18 2006; Barcelo, 2001). Neuroimaging and patient
19 studies of the Stroop test suggest it is associated with
20 superior medial frontal and inferior lateral frontal
21 regions rather than ventral frontal cortex proper
22 (e.g., Stuss, et al., 2001; Demakis, 2004). Patient
23 studies of Trails A & B show that completion time
24 on Trails B, not errors, seems to be the most sensi-
25 tive measure, but even that is sensitive to damage in
26 dorsolateral prefrontal cortex rather than ventral
27 frontal cortex (Stuss, et al., 2001; Demakis, 2004).
28 Several studies show sensitivity to frontal damage
29 on most but not all subtests of the D-KEFS (e.g.,
30 Delis, Kramer, Kaplan, & Holdnack, 2004; Keil,
31 Baldo, Kaplan, Kramer, & Delis, 2005; McDonald,
32 Delis, Norman, Tecoma, & Iragui, 2005), and the
33 Verbal Fluency and Category Switching subtests
34 seem to be sensitive to TBI, with mixed results for
35 the Design Fluency subtest (Strong Tiesma, &
36 Donders, 2010; Varney et al., 1996) and ventral
37 frontal damage (Boone et al., 1999). On the more
38 positive side, the Hayling Sentence Completion
39 Test is associated with damage to the frontal lobes
40 generally rather than specifically ventral damage
41 (Burgess & Shallice, 1997), but it is one of the exec-
42 utive tests most sensitive to TBIⁱ (Ponsford et al.,
43 2008). Poor performance on Go/No-go tests is asso-
44 ciated with TBI and damage to the ventral frontal
45 cortex (e.g., Gagnon, Bouchard, Rainville, Lecours,
46 & St-Amand, 2006; Robertson et al., 1997).

47 *Links to real-world outcomes*

48 The most notable gap in the development of many
49 of these executive tests is the absence of studies link-
50 ing the tests with real-world functional outcomes.
51 By functional outcome, we mean some measure of

the patient's adjustment in daily life, for example, 52
53 assessing the ability to drive, make friends, hold a
54 job, or assessing real-world behavioral problems.
55 Test manuals rarely include studies investigating
56 these properties of the tests, in spite of how crucial
57 such information is for clinicians. For some tests,
58 researchers have established such links, and we hope
59 that people developing tests in the future will inves-
60 tigate real-world correlates of poor test performance
61 as a routine and necessary part of test development.
62 To our knowledge, there are no studies establishing
63 a link between performance on tower tests or cogni-
64 tive estimates tests and real-world functioning. Only
65 modified, treatment-specific versions of the Stroop
66 task have been associated with treatment outcomes
67 (Carpenter, Schreiber, Church, & McDowell, 2006;
68 Carter, Bulik, McIntosh, & Joyce, 2000). The Trail-
69 Making and Verbal Fluency tests have been linked
70 to the ability to perform activities of daily living in
71 older adults (Cahn-Weiner, Boyle, & Malloy, 2002).
72 The Wisconsin Card Sorting Test has been linked
73 to the need for supervision and to employment
74 status (Benge, Caroselli, & Temple, 2007; Greve,
75 Bianchini, Hartley, & Adams, 1999; Moritz, et al.,
76 2005). The Hayling test correlates with patients'
77 functional status as reported by a caregiver in a
78 structured interview (Odhuba, van den Broek, &
79 Johns, 2005), and the Go/No-Go task has been
80 linked to everyday action slips (Robertson, et al.,
81 1997).

82 Linking test performance to functional outcome
83 is perhaps the most important of all aspects of test
84 development. While the absence of norms may
85 necessitate qualitative evaluations of test perfor-
86 mance, and a lack of anatomical specificity may
87 mean that corroborative neuroimaging is required
88 for lesion-localization, an absence of a relationship
89 between task performance and patients' real world
90 functioning makes the value of the test question-
91 able. When clinicians or researchers use tests of
92 executive functions that are insensitive to ventral
93 frontal damage or TBI, they risk failing to identify
94 such patients' real lack of competency, or failing to
95 find associations that might be there if more appro-
96 priate tests were used. Patients with brain injuries
97 may be denied disability benefits if the cognitive
98 tests used do not capture their particular difficulties.
99 Thus, we strongly encourage clinicians and research-
100 ers to use only those executive tests most likely to be
101 sensitive to TBI and/or ventral frontal damage with
102 such patients.

103 Finally, when clinicians and researchers limit
104 assessment of patients with ventral frontal damage

1 or TBI to assessment only of cognitive, executive
2 functions, they may miss one of the most important
3 areas of disability. The limitation to cognitive assess-
4 ments has serious, real-world consequences. Patients
5 whose deficits are more social and emotional than
6 cognitive may be denied benefits, and in some cases,
7 they may even be accused of “malingering” because
8 the way in which they were tested does not capture
9 their disability (e.g., Eslinger & Damasio, 1985).
10 Thus, more widespread use of objective measures of
11 social competence is necessary for patients to be
12 treated appropriately.

13 **Performance Measures of Social** 14 **Competencies in Patients with** 15 **Ventral Frontal Damage and TBI**

16 As with the assessment of executive functions
17 (Gioia & Isquith, 2004), it will be necessary to mea-
18 sure multiple abilities in order to accurately assess a
19 person’s social competence. In the following section,
20 we review some of the tasks developed for this pur-
21 pose, and evaluate the clinical utility of these tests
22 according to two criteria of central importance
23 in neuropsychological test development (Ardila,
24 Ostrosky-Solis, & Bernal, 2006): whether the tasks
25 are sensitive to the difficulties present in neurologi-
26 cal patients who present with social difficulties, spe-
27 cifically, ventral frontal damage or TBI, and whether
28 performance on these tasks has been associated with
29 real-world social functioning (Burgess et al., 2006).
30 Our purpose here is to identify the measures that
31 are most useful for assessments of social competen-
32 cies from those that are currently available.

33 ***Theory of Mind Tasks in Patients with*** 34 ***Ventral Frontal Damage and TBI***

35 Several researchers have looked at theory of mind
36 (ToM) in patients with ventral frontal damage, with
37 the idea that deficits in ToM might underlie the
38 patients’ social difficulties. The term “theory of mind”
39 suffers from many of the same conceptual problems
40 as the term “executive function”: 1) in practice, in
41 the field of neuropsychology, it refers to a set of
42 abilities rather than a unitary ability; 2) a variety of
43 tasks are used to test it; 3) not all of these tasks mea-
44 sure the same ability; and 4) not everyone agrees that
45 ToM is a distinct cognitive module (e.g., Stone &
46 Gerrans, 2006). Furthermore, different groups of
47 researchers use the term to mean different things. In
48 the social neuroscience literature, ToM has often
49 been construed broadly as “the ability to infer others’
50 mental states” (Stone et al., 2003; Bibby & McDonald,
51 2005; Shamay-Tsoory & Aharon-Peretz, 2007;

52 Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-
53 Peretz, 2005; Shamay-Tsoory, Tomer, Berger, &
54 Aharon-Peretz, 2003; Stone, 2007). “Mental states”
55 might include intentions, thoughts, beliefs, emo-
56 tions, focus of attention, and attitudes. Within
57 developmental and cognitive psychology, however,
58 ToM has a more narrow usage, referring *only* to the
59 ability to do metarepresentation, that is, the ability
60 to understand that mental states of knowledge and
61 belief represent the world, and thus that such mental
62 states can be mistaken (e.g., Baron-Cohen, Leslie,
63 & Frith, 1985; Saxe, Carey, & Kanwisher, 2004;
64 Stone & Gerrans, 2006). In the developmental/cog-
65 nitive psychology view, “theory of mind” means *only*
66 inferring others’ knowledge and beliefs, and specifi-
67 cally excludes inferences about affective mental
68 states (Leslie & Frith, 1990). As detailed below,
69 there is little evidence that patients with ventral
70 frontal damage are specifically impaired in belief
71 understanding and metarepresentation. Their diffi-
72 culties instead seem to be with understanding
73 others’ intentions and feelings.

74 The tasks that different researchers use to assess
75 ToM demonstrate differences in how they use the
76 term. With a narrow definition of ToM, as in the
77 developmental/cognitive psychology view, the only
78 valid task is a false belief task (see details below), in
79 which the researcher tests whether the participant
80 can infer when someone else’s belief state is mis-
81 taken. In contrast, with the broader definition of
82 ToM used in most social neuroscience research,
83 tasks examining inferences about intention, atten-
84 tion, sarcasm, empathy, as well as false beliefs have
85 all been used as measures of ToM (Stone, 2007;
86 Stone & Gerrans, 2006). These tasks may involve
87 listening to or seeing brief stories, cartoons, or pic-
88 tures, and then inferring characters’ intentions, feel-
89 ings, focus of attention, and beliefs, or recognizing
90 when something awkward has been said. Several
91 different tests, besides false belief tests, are used for
92 testing the understanding of others’ mental states
93 (see Table 31.2), and we will discuss each one in
94 more detail below. If ToM is more broadly defined
95 to include inferences about mental states such as
96 intentions, feelings, and focus of attention, patients
97 with ventral frontal damage and TBI can be shown
98 to have ToM deficits.

99 ***False Belief Tasks-Understanding*** 100 ***of Knowledge and Belief***

101 *Description of the Task*

102 False belief tasks ask participants to make an infer-
103 ence about what a story character would think or

Table 31.2 Summary of tests of theory of mind in terms of social competences measured, sensitivity to ventral frontal damage or TBI, and correlations with measures of functional outcome.

Name of Test	Social Competences Measured	Test Performance Affected by TBI or Frontal Damage?	Links to Functional Outcome
False belief	Inferring contents of others' knowledge and beliefs	No	No*
Charlie & the Chocolates (Cognitive Version)	Inferring intentions or language reference from eye gaze	Maybe ventral frontal damage from FTD**	Not tested
Charlie & the Chocolates (Affective Version)	Inferring desires from eye gaze	No	Not tested
Reading the Mind in the Eyes-Original Version	Inferring cognitive & affective mental states from eyes	Ventral frontal damage from FTD	No
Happé's Strange Stories (& variants)	Inferring thoughts, beliefs, intentions	Inconsistent results, maybe ventromedial frontal damage	Not tested
Strange Stories-Affective Version	Inferring feelings	No	Not tested
Sarcasm/Irony	Detecting sarcasm or irony by inferring intentions and/or feelings	TBI, ventral frontal damage	Not tested
Faux Pas Recognition	Inferring beliefs, intentions, feelings	TBI, ventral frontal damage	Neuropsychiatric Index Scores (NPI), & maybe Neuropsychology Behavior & Affect Profile
Cartoon tests	Inferring beliefs, intentions	Inconsistent results	No

* Only second-order false belief tasks were related to Neuropsychiatric Index Scores, not first-order false belief; thus the correlation could result from the working memory demands of second-order tasks.

** FTD = frontotemporal dementia. Unknown whether FTD patients did poorly on this test because of social competence deficits or cognitive inhibitory deficits—no control condition run.

1 believe in a situation in which the story character's
 2 belief could be mistaken. A common type of false
 3 belief task is a "location-change" task, in which a
 4 story character puts an object away, say in a drawer,
 5 and then leaves the room. Another character moves
 6 the object when the first cannot see, and later the
 7 first character comes back into the room. The key
 8 question is where the first character now thinks the
 9 object is, or where she will look for the object.
 10 The methods involve either showing the participant
 11 the story in pictures, reading it to them, or having
 12 them read the story. Then participants answer ques-
 13 tions about the character's belief, as well as control
 14 questions testing for memory, comprehension, and
 15 (in some cases) inferential abilities (e.g., Stone et al.,
 16 1998).

17 There are also different "orders" of false belief
 18 tests. In a first-order false belief test, one is simply

asked what the first character thinks or believes, 19
 testing understanding of, say, "Maria thinks that 20
 [X is true]." In a second-order task, another level of 21
 embedding is added, testing understanding of, say, 22
 "Jose thinks that Maria thinks that [X is true]." For 23
 example, if Maria put an object away and left the 24
 room, the story might depict her peeking back 25
 through a keyhole and seeing Jose move the object 26
 to another location. In that case, Maria would not 27
 hold a false belief about the object, but Jose would 28
 hold a false belief about Maria's belief, thinking that 29
 she didn't know where it was moved to (Baron- 30
 Cohen, 1995). This process can be extended to fur- 31
 ther levels of embedding. A third-order task would 32
 test understanding of statements such as "Katrin 33
 thinks that Alex believes that Katrin does not know 34
 that Alex is having an affair." Higher orders are 35
 possible, but after three levels of embedding, the 36

1 working memory demands of parsing the embed-
2 ded clauses make the task extremely difficult. It has
3 not been established that second- or third-order
4 false belief tests truly test a greater level of ability to
5 infer *mental states*; instead, they may simply add
6 greater linguistic and working memory demands to
7 the first-order task (Stone, 2007).

8 *Relationship to Ventral Frontal Damage and TBI*

9 Results on frontal patients' performance on false
10 belief tasks are mixed, and there is a good method-
11 ological reason for these mixed results. Sound meth-
12 odology requires controlling for other, non-ToM
13 factors involved in performance on ToM tasks (Bibby
14 & McDonald, 2005; Stone, 2005; Stone, et al.,
15 1998). ToM tasks require not only an intact capacity
16 to metarepresent beliefs, but also an intact ability to
17 make inferences, intact working memory, and inhi-
18 bition of one's own belief state or personal preference
19 to determine someone else's belief state or preference
20 (Carlson & Moses, 2001; Henry, Phillips, Crawford,
21 Ietswaart, & Summers, 2006; Stone, 2005; Stone
22 et al., 1998; Stone & Gerrans, 2006).

23 Where the working memory demands of false
24 belief tasks have been controlled for, for instance by
25 placing pictures depicting the sequence of events in
26 front of the participant throughout the session, def-
27 icits on false belief tasks are not always evident
28 (Bibby & McDonald, 2005; Gregory, Lough, Stone,
29 Erzincliglu, Martin, Baron-Cohen, & Hodges,
30 2002; Muller, Simion, Reviriego, Galera, Mazaux,
31 Barat, & Joseph, 2010; Stone et al., 1998). Stone
32 et al. (1998) found that patients with orbitofron-
33 tal damage were at ceiling on false belief tasks on
34 all conditions, and that patients with dorsolateral
35 frontal damage had no deficits when the working
36 memory demands were lowered. Gregory et al. (2002)
37 found that patients with ventral frontal atrophy
38 from frontotemporal dementia performed best on
39 first-order false belief tasks across three different
40 ToM tasks. Stone and Baron-Cohen tested 5 patients
41 with ventral frontal damage on first-, second- and
42 third-order false belief tasks with control tasks requir-
43 ing first-, second- and third-order non-mentalistic
44 inferences, and found that the patients were not
45 specifically impaired on the false belief tasks com-
46 pared to the control tasks, though higher orders of
47 embedding were more difficult on both types of task
48 (Stone, 2007). Bibby and McDonald (2005) tested
49 whether TBI patients could understand false beliefs,
50 controlling for working memory with Digit Span
51 (backwards), and found no evidence for specific
52 deficits on these tasks in the patient group.

Failing to control for working memory demands 53
might include using video versions of the tasks, or 54
versions where the action is acted out in some other 55
way, so that the patient has to rely on working 56
memory to keep track of what happened when and 57
to whom. Where the working memory demands 58
have *not* been controlled for, some studies have 59
found deficits on false belief tasks (Stuss, 2001; 60
Fernandez-Duque, Baird, & Black, 2008), and 61
others have not (Shamay-Tsoory & Aharon-Peretz, 62
2007; Shamay-Tsoory, Tomer, et al., 2005; Snodgrass 63
& Knott, 2006). Shamay-Tsoory, Tomer, et al. 64
(2005) used second-order false belief tasks, and 65
found that patients with ventromedial frontal 66
lesions had no difficulty with these tasks. 67

68 Thus, for false belief tasks, which narrowly test
69 for understanding of others' knowledge and belief
70 states, there is scant evidence that patients with fron-
71 tal lobe damage or TBI have deficits (Stone &
72 Gerrans, 2006). In contrast, patients with posterior
73 lesions in the temporal-parietal junction have spe-
74 cific difficulty with false belief tasks and other tests of
75 metarepresentation, controlling for language, work-
76 ing memory, and inhibitory task demands (Apperly,
77 Samson, Chiavarino, Bickerton, & Humphreys,
78 2007; Apperly, Samson, Chiavarino, & Humphreys,
79 2004; Apperly, Samson, & Humphreys, 2005).

Links to Functional Outcome 80

81 In frontotemporal dementia patients, Gregory et al.
82 (2002) measured behavioral disturbance and func-
83 tional problems using the Neuropsychiatric Index
84 (NPI), an index of behavioral problems common in
85 dementia patients, such as problems with inhi-
86 bition, motivation, and aggression (Cummings et al.,
87 1994). First-order false belief tasks were not related
88 to NPI scores, but second-order false belief tasks did
89 predict NPI scores. It is possible that second-order
90 false belief scores reflected working memory deficits
91 rather than ToM deficits, because of the memory
92 load involved in parsing embedded clauses in high-
93 er-order false belief tasks (Gregory et al., 2002). To
94 our knowledge, no other researchers have investi-
95 gated the relationship between false belief under-
96 standing and patient's functioning.

The Charlie and the Chocolates Test—Inferences About Intention and Eye Gaze 97

Description of the Task 100

101 This test, originally designed for children who
102 are too young to pass false belief tests, investi-
103 gates whether participants can determine desire for,

1 intention towards, or attention to an object from
2 the eye-gaze direction of a cartoon character (Baron-
3 Cohen, 1995). Typically, the response is chosen
4 from four options. A cartoon character in the center
5 of the display, “Charlie,” looks at one of four objects
6 arrayed around him. The participant is asked,
7 “Which one does Charlie want?” or “Which one
8 will Charlie take?” Young children also use adults’
9 direction of eye gaze to determine which object an
10 unfamiliar word refers to, so in this task, if the stimuli
11 are meaningless shapes, the experimenter can ask
12 a question about which shape Charlie is referring to
13 with a novel nonsense word when he looks at it, by
14 asking, for example, “Which one does Charlie say is
15 the bleb?” (Baron-Cohen, 1995).

16 Shamay-Tsoory and Aharon-Peretz (2007) cre-
17 ated “cognitive” and “affective” versions of this task.
18 A “cognitive” item showed the character looking at
19 an object, and asked something like, “Yoni is think-
20 ing of _____” (which one)? An “affective item
21 would ask something like, “Yoni loves _____”
22 (which one)? They also created second-order ver-
23 sions of the items that probed understanding of
24 a character thinking about a toy that another char-
25 acter likes, or liking/not liking a toy that another
26 character likes.

27 *Relationship to Ventral Frontal Damage and TBI*

28 In addition to testing the ability to infer desire or
29 intention from eye gaze, the Charlie and the
30 Chocolates task has significant inhibitory demands.
31 In order to tell the experimenter that the cartoon
32 character intends to, say, take a particular chocolate
33 bar he is looking at, the participant must suppress
34 her desire for her own preferred chocolate bar
35 (Stone, 2005). Thus, although Snowden and col-
36 leagues (2003) found that frontotemporal dementia
37 patients were impaired on the task, it is difficult to
38 know whether the impairment was due to deficits in
39 inhibition or in mental state inference.

40 Shamay-Tsoory and Aharon-Peretz (2007) gave
41 their version of this task to three groups of patients,
42 one group with dorsolateral frontal lesions, one
43 with ventromedial frontal lesions (including some
44 lesions that extended back to temporal cortex), and
45 one with posterior lesions, as well as age-matched
46 healthy controls. No group differences were evi-
47 dent on the basic version of the task, but in the
48 second-order condition, patients with ventromedial
49 damage were significantly impaired relative to the
50 healthy controls. However, no significant differ-
51 ences were reported between the group with ventro-
52 medial damage, and those with dorsolateral frontal

or posterior damage. Patients with left frontal lesions
(whether ventral or dorsolateral) scored significantly
lower on the affective items on this task compared
to the cognitive items. Thus, evidence that this task
is sensitive and specific to ventral frontal damage is
not strong.

Relationship to functional outcome

To our knowledge, no one has yet investigated the
relationship between this task and behavioral prob-
lems or adjustment in patients.

The Reading the Mind in the Eyes Test—Original Version

Description of the Task

This test is often used as a ToM test (Gregory
et al., 2002; Henry, Phillips, Crawford, Ietswaart, &
Summers, 2006; Milders, Fuchs, & Crawford,
2003; Stone et al., 2003; Torralva et al., 2007).
Some confusion in the literature results from there
being two versions of the test. The *original version* of
the test (Baron-Cohen et al., 1997) includes not
only 17 items asking about subtle emotional states,
but also 8 items asking about more cognitive mental
states—intention or focus of attention (e.g., “noticing
you/ignoring you,” “observing/daydreaming,” Stone
et al., 2003). The original version also had only two
response choices, making it more difficult to distin-
guish participants’ performance from chance. The
revised version (Reading the Mind in the Eyes-R,
Baron-Cohen, Wheelwright, Hill, Raste, & Plumb,
2001) eliminates all items that ask about focus of
attention or intention, and has items only about
subtle emotional states. It also has four response
choices instead of two. Because the revised version
asks only for inferences about emotional states,
researchers categorize it as a measure of emotion
recognition, rather than a ToM task. Emotion rec-
ognition is not considered to be ToM by many
researchers, because it is more automatic than infer-
ences about beliefs, knowledge, or attention, devel-
ops earlier, and does not require the same kinds
of representations (Leslie & Frith, 1990; Stone,
2003).

Relationship to Ventral Frontal Damage and TBI

In Gregory et al’s (2002) study, using the original
version of the test, patients with ventral frontal atro-
phy from frontotemporal dementia had deficits on
both affective and nonaffective items compared
to healthy controls and patients with Alzheimer’s
disease. Reading the Mind in the Eyes did not
correlate with any other ToM tasks in this study,

1 neither first- and second-order false belief, nor Faux
2 Pas Recognition (described below).

3 Milders, Fuchs, and Crawford (2003) and Henry
4 et al. (2006) found that patients with TBI were
5 impaired on the revised emotion-recognition ver-
6 sion of the task, and Torralva et al. (2007) found
7 that frontotemporal dementia patients were also
8 impaired on the revised task. Although all authors
9 used the phrase “theory of mind” in the titles of
10 their papers, they used the *revised* version of the
11 task, and thus these patients may have had deficits
12 in emotion-recognition rather than deficits in other
13 kinds of mental state inference.

14 *Links to Functional Outcome*

15 In frontotemporal dementia patients, Gregory et al.
16 (2002) found no relationship between NPI scores as
17 a measure of behavioral disturbance, and scores on
18 the original version of Reading the Mind in the
19 Eyes. To our knowledge, no one else has looked at
20 the association between the original version of the
21 Eyes task and behavioral outcomes for patients with
22 ventral frontal damage or TBI.

23 ***Happé’s Strange Stories Test and*** 24 ***Variants—Mixed Mental State Inferences***

25 *Description of the Task*

26 Some story-based tasks are not specific to particular
27 kinds of inferences about others’ internal states, such
28 as belief, but instead look at participants’ ability to
29 infer several mental states from a verbal story, that is,
30 a story characters’ thoughts, feelings, and intentions
31 (Channon, Pellijeff, & Rule, 2005; Happé, 1994;
32 Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-
33 Tsoory, Tomer, & Aharon-Peretz, 2005a). In Happé’s
34 Strange Stories test (1994), participants read a brief
35 story in which a character does something, such as
36 a spy telling a lie to deceive his interrogators, or a
37 person telling a white lie about how nice someone’s
38 awful new haircut looks. (For examples, see pp. 12–13
39 in Gallagher et al., 2000.) Questions following the
40 story probe whether the participant understood the
41 story character’s intentions (e.g., Why did the person
42 say the haircut looked good?), beliefs, or feelings.
43 Control stories and questions about those stories
44 require non-mentalistic inferences, for example,
45 inferences about physical processes.

46 Shamay-Tsoory et al. (2007) created a version
47 with brief stories that asked either about what a
48 story character thinks about another character’s
49 *beliefs* (second-order false belief) or what a story
50 character thinks about how another character *feels*,
51 which they called second-order affective ToM,

and thus they could compare what they called 52
“cognitive” and “affective” ToM. 53

54 *Relationship to Ventral Frontal Damage and TBI*

55 Little evidence exists that performance on this task
56 is impaired by ventral frontal damage, specifically.
57 Snowden et al. (2003) found that patients with ven-
58 tral frontal damage from FTD were not impaired
59 on mental-state stories compared to control stories
60 on this task. Shamay-Tsoory and Aharon-Peretz
61 (2007), on their affective versus cognitive mental
62 states version of the task, found that there were no
63 differences between patients with ventromedial
64 frontal or posterior lesions or controls on the cogni-
65 tive version, but that ventromedial frontal patients
66 were significantly impaired relative to patients with
67 posterior lesions on affective items.

68 Patients with TBI have also been tested on ver-
69 sions of this task. Bibby and McDonald (2005) pre-
70 sented TBI patients with a Stories task, controlling
71 for working memory and language demands, but
72 found no deficits specific to the ToM stories as
73 opposed to control stories in patients. Channon,
74 Pellijeff, and Rule (2005) found that TBI patients
75 were not impaired on mentalistic items relative to
76 healthy controls when they had to choose the correct
77 response from four choices, but TBI patients did have
78 selective difficulty interpreting mentalistic actions in
79 the stories compared to physical actions. Bach et al.
80 (2000), in a case study of a TBI patient, found that
81 he performed as well as both older and younger con-
82 trols. They note his particular strength in making
83 affective inferences about story characters’ feelings.
84 Although their findings are of limited use because
85 they did not compare patients to controls, Bach and
86 David (2006) found that performance on the task
87 predicted TBI patients’ social self-awareness. Social
88 self awareness was measured by self-other rating dis-
89 crepancies on the Patient Competency Rating Scale,
90 a scale measuring behavioral problems and how well
91 a patient can manage independent living.

92 For reported results on tasks of this type to make
93 sense, researchers must report not just a total score
94 for the task, but also separate scores for each type
95 of mental state asked about, for example, a “feelings
96 inference score,” an “intentions inference score,”
97 a “beliefs inference score.” Because these tasks assess
98 the understanding of several kinds of mental states,
99 a total score is difficult to interpret. A patient could
100 be impaired in inferring others’ intentions, for
101 example, but not impaired in inferring feelings or
102 vice versa. Indeed, people with TBI and people with
103 ventral frontal damage seem to be more impaired in

1 inferring intentions or feelings than they are in
2 inferring others' false beliefs (Stone, 2005). As fur-
3 ther evidence of dissociability in these abilities, evi-
4 dence suggests that emotional perspective-taking is
5 associated with ventral frontal activation, whereas
6 nonemotional perspective-taking is not (Hynes,
7 Baird, & Grafton, 2006). Thus, it would be useful
8 to have results on these tasks reported by type of
9 mental state inference.

10 There is only one study with clear evidence show-
11 ing that tasks of this type are sensitive to ventral fron-
12 tal damage or TBI (Shamay-Tsoory & Aharon-Peretz,
13 2007), and several studies showing that it is not
14 (Bach, et al., 2000; Bibby & McDonald, 2005;
15 Snowden et al., 2003). We can make sense of these
16 different findings by considering that Shamay-Tsoory
17 and Aharon-Peretz (2007) make distinctions between
18 type of mental state inference in reporting their
19 results. The patients in Shamay-Tsoory and Aharon-
20 Peretz (2007) were required to make either cognitive
21 or affective inferences about others' mental states,
22 and the demonstrated deficit was only in affective
23 inferences. Thus, the type of mental state (feeling,
24 belief, intention) about which patients make infer-
25 ences is crucial to interpreting the patients' scores or
26 group differences. We encourage other researchers to
27 report results on these tasks as a "feelings infer-
28 ence score," an "intentions inference score," a "beliefs
29 inference score," not just a total score, so that the type
30 of inference that is difficult for the patient is clear.

31 *Links to Functional Outcome*

32 Thus far, there are no indications that performance
33 on this task relates to patients' functional outcomes,
34 though little research has been done investigating
35 that question. Bach and David (2006) found no sig-
36 nificant difference in performance on Happé's Strange
37 Stories test between "behaviorally disturbed" and
38 "non-behaviorally disturbed participants." Behavioral
39 disturbance was operationalized as relatives' ratings of
40 the patients on the Patient Competency Rating Scale,
41 a measure of behavioral problems and how well a
42 patient can manage independent living. The absence
43 of a strong relationship between these tasks and mea-
44 sures of functional outcome in TBI patients is consis-
45 tent with the fact that patients with TBI are often
46 able to perform well on the task.

47 *Detection of Sarcasm/Irony Tasks*

48 *Description of the Tasks*

49 These tasks are quite similar to Happé's Strange
50 Stories task, but with the items restricted to under-
51 standing story characters' use of sarcasm (also called

irony in some studies), that is, saying the opposite of
52 what they mean. For example, it is sarcastic to say,
53 when someone has clumsily dropped something,
54 "You're so graceful" or "Why don't you go into neu-
55 rosurgery?" The participant reads a story, and is
56 asked why someone said what they said, when the
57 utterance was sarcastic, or what someone meant by
58 such an utterance (Channon, et al., 2005; Channon,
59 et al., 2007; McDonald & Pearce, 1996; Shamay-
60 Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory,
61 Tomer, & Aharon-Peretz, 2005; Shamay-Tsoory,
62 Tomer, Berger, Goldsher, & Aharon-Peretz, 2005).
63 Control stories may contain a sincere utterance. The
64 stories are presented in writing, so that tone-of-voice
65 cues do not give away when a character is being
66 sarcastic. Sarcasm comprehension may tap into an
67 understanding of others' intentions, and the social
68 context, because the participant has to understand
69 the speaker's true intention, separate from the literal
70 content of the speaker's statement. An advantage of
71 these tasks over the Strange Stories tasks is that sar-
72 casm-comprehension tasks test understanding of
73 intentions, rather than many different types of
74 mental states. 75

Relationship to Ventral Frontal Damage and TBI

76 Several studies have demonstrated that this task
77 is sensitive to ventral frontal damage and TBI.
78 Patients with TBI are impaired in understanding
79 sarcasm as opposed to sincere statements, relative to
80 healthy controls (Channon et al., 2005; McDonald
81 & Pearce, 1996). Patients with ventral frontal lesions
82 are also impaired in understanding sarcasm, but not
83 sincere statements, compared to patients with pos-
84 terior lesions, dorsolateral frontal lesions, or healthy
85 controls (Shamay-Tsoory, Tomer, & Aharon-Peretz,
86 2005; Shamay-Tsoory, Tomer, Berger, et al., 2005).
87 There was no significant relationship between
88 sarcasm-comprehension deficits and frontal or pos-
89 terior lesion size in another study (Shamay-Tsoory
90 et al., 2005b) Kosmidis et al. (2008) found patients
91 with frontotemporal dementia were impaired at
92 using paralinguistic cues to detect sarcasm or lies,
93 but could perform well when more verbal cues indi-
94 cating sarcasm were given. Thus, many studies con-
95 firm that this task differentiates people with TBI
96 from healthy controls, and people with ventral fron-
97 tal damage from those with dorsolateral frontal
98 lesions, posterior damage, and healthy controls. 99

Links to Functional Outcome

100 No studies, to our knowledge, have investigated the
101 relationship of performance on sarcasm detection 102

1 tasks to patients' behavioral outcomes or ability to
2 engage in activities of daily living. Shamay-Tsoory,
3 Tomer, Berger, et al.(2005), however, did find that
4 greater depression, as indicated by scores on the
5 Beck Depression Inventory, was a strong predictor
6 of lower sarcasm-comprehension scores, though the
7 difference between ventral frontal patients and pos-
8 terior lesion and healthy control groups could not
9 be attributed to depression scores. This finding
10 implies that the aspects of impaired social compe-
11 tence measured by sarcasm tasks may contribute to
12 social rejection and depression.

13 **Cartoon Tasks**

14 *Description of the Tasks*

15 Cartoon tasks have the advantage of testing mental
16 state inferences without requiring comprehension
17 of a verbal story. They use a small number of visual
18 cartoons that require an inference about a charac-
19 ter's feelings, intentions, focus of attention, or beliefs
20 to understand the joke (Gallagher et al., 2000;
21 Happé et al., 1999). Control cartoons require a
22 physical inference to get the joke, for example three
23 (presumably blind) mice are asleep in a bed with
24 three tiny pairs of sunglasses on the nightstand. (For
25 examples, see page 14 in Gallagher et al., 2000.)
26 Participants view each cartoon and explain why it is
27 funny. Responses on each are scored from 0 to 3
28 points, depending on the relevance and correctness
29 of the answer. Responses can also be scored for how
30 many mental state terms are used in explaining the
31 cartoon. A related task asks participants to look at a
32 pair of cartoons, one of which is funny, the other of
33 which is not, and choose the funny one (Happé
34 et al., 1999). Half of the cartoons require mental
35 state inferences to get the joke, and half do not.

36 As with the Strange Stories Task, these tasks
37 examine the understanding of several types of
38 mental states, such as intentions, beliefs, or focus
39 of attention. One cartoon is funny because of focus
40 of attention: a man is looking at a piano bench that
41 has crashed onto the sidewalk, and has not noticed
42 the piano hurtling towards him from above. Another
43 is funny because of a character's lack of knowledge/
44 false belief: an astronomer does not realize he has
45 black rings around his eyes because his colleagues
46 have put black charcoal around the eye piece of the
47 telescope he has been looking through. Again, we
48 encourage researchers to report scores broken down
49 by type of mental state inference required (inten-
50 tions, knowledge, belief, feelings, focus of atten-
51 tion). About two-thirds of the items in the version
52 used by Happé and colleagues (1999), however,

do seem to depend on false belief. Thus, a total
score on this version of the task can reasonably
be interpreted as primarily reflecting false belief
understanding.

Relationship to Ventral Frontal Damage and TBI

Attempts to link performance on this task to frontal
lobe lesions or TBI have produced inconsistent
results. Snowden et al. (2003) found that patients
with ventral frontal atrophy from frontotemporal
dementia produced fewer mental state verbs in their
responses to this task, and made more errors in inter-
preting mental state cartoons versus control cartoons
when compared to patients with Huntington's and
to healthy controls. When Bibby and McDonald
(2005) controlled for working memory deficits
using digits backwards from Digit Span, TBI
patients showed a deficit specific to mental state
inferences on the cartoon task. Milders et al. (2006)
found no deficit specific to mental state inferences
in TBI patients relative to neurologically healthy
controls with orthopedic injuries on the cartoon
task when the patients were tested shortly after
injury, but scores for the mentalistic cartoons were
correlated with scores on Alternating Fluency, a test
of cognitive flexibility in which participants gener-
ate words in categories, alternating between three
categories. Cartoon task scores were not correlated
with severity of TBI (as measured by Glasgow Coma
Scale scores). One year later, the same TBI patients
showed a significant improvement in performance
on the mentalistic cartoons relative to the orthope-
dic controls. Milders et al. (2008) also used the car-
toon task with only mental-state cartoons to test
another group of TBI patients. TBI patients were
significantly impaired relative to matched controls
with only orthopedic injuries both soon after their
injuries and at one-year follow-up. Bach and David
(2006) found that performance on this task pre-
dicted TBI patients' social self-awareness (as mea-
sured by self-other rating discrepancies on the
Patient Competency Rating Scale), but their study
did not compare patients to controls, so they provide
no information as to its sensitivity to TBI. They also
report that performance on both Happé's Strange
Stories and cartoon tasks was "associated with a lim-
ited number of executive function tests" (Bach &
David, 2006 p. 407), but report neither which tests
they used, nor the correlations. Because performance
on cartoon-based tasks may be affected by many
non-ToM factors (working memory, some execu-
tive functions, and perceptual abilities), researchers
should partial out other cognitive differences in

1 patient groups. Because results on sensitivity of cartoon-based tasks to ventral frontal damage and TBI
2 are mixed, clinicians may not find these tasks most
3 useful for testing patients' social competencies.
4

5 *Links to Functional Outcome*

6 The little research that has been done testing the
7 relationship between cartoon task performance and
8 functional outcomes for patients indicates no relationship.
9 Milders et al. (2006) found no relationship
10 between a composite measure consisting of
11 cartoon task performance and Faux Pas Recognition
12 task performance, and informant ratings on the
13 Katz Adjustment Scale, which measures social
14 behavior problems, whether shortly after injury or
15 at one-year follow-up. Bach and David (2006)
16 found no significant difference in performance
17 between TBI participants who were "behaviorally
18 disturbed" and those who were not, with behavioral
19 disturbance measured as relatives' ratings of
20 the patients on the Patient Competency Rating
21 Scale.

22 ***Faux Pas Recognition Task***

23 *Description of the Task*

24 A faux pas is an awkward or insulting statement
25 made unintentionally. The task involves reading a
26 brief story out loud while the patients read along on
27 their own copy. In the faux pas stories, someone says
28 something awkward or insulting, while in the control
29 stories a minor conflict occurs, but no faux
30 pas (Gregory, et al., 2002; Stone, et al., 1998). The
31 patient has a copy of the story in front of them to
32 reduce any memory demands. Several questions are
33 asked that assess whether the participant understands
34 that something awkward has been said, why
35 it was inappropriate to say it, that it was said unintentionally,
36 and that one character might have felt
37 bad as a result of the faux pas. Control comprehension
38 questions test for general comprehension of
39 story facts, apart from mental state understanding.
40 Although this measure was originally introduced as
41 a measure of ToM (Gregory, et al., 2002; Stone,
42 et al., 1998), it measures multiple abilities: false
43 belief understanding, empathy, inferences about
44 intentions, knowledge of appropriate social behavior,
45 as well as language comprehension. Stone (2000;
46 2005) has noted that ventral frontal patients typically
47 make three types of errors: 1) *faux pas errors*:
48 failing to detect a faux pas, or a false faux pas identification
49 in the control stories; 2) *intentionality errors*:
50 noticing that something awkward has been
51 said, but stating that it was said intentionally instead

of accidentally; or 3) *appropriateness errors*: failing to
52 identify the reason that the comment was inappropriate.
53 As noted in the false belief section above, it
54 seems unlikely that ventral frontal patients cannot
55 track false beliefs, as they generally perform at or
56 close to ceiling on false belief tasks. Their faux pas
57 errors on the Recognition of Faux Pas Test sometimes
58 reflect a difficulty inferring that something
59 hurtful has been said, perhaps because they do not
60 notice the "oohhh!" gut response that most people
61 experience when hearing such stories, because of
62 impaired physiological responsivity caused by TBI
63 (e.g., de Sousa, McDonald, Rushby, Li, Dimoska,
64 & James, 2010). At other times, their errors reflect
65 a difficulty tracking others' intentions, resulting in
66 the misperception that the comment was deliberate
67 (intentionality errors), or a difficulty perceiving
68 what would lead to others' distress (appropriateness
69 errors), resulting in failure to detect the faux pas.
70 Such errors are rarely made by controls without
71 brain damage (Gregory, et al., 2002; Stone, 2000;
72 Stone, et al., 1998).
73

74 Interpretation of the Recognition of Faux Pas
75 Test in the literature is made more difficult by differences
76 in how the errors are reported. Researchers
77 do report faux pas errors (see hit rates and correct
78 reject rates in Gregory, et al., 2002), but it is rare for
79 researchers to report differences between intentionality
80 errors and appropriateness errors (but see
81 Stone, et al., 1998). These two types of errors tend
82 to be lumped together into a "composite score" or a
83 "follow-up questions score" (Gregory, et al., 2002;
84 Lough & Hodges, 2002; Milders, et al., 2003;
85 Milders, et al., 2006; Shamay-Tsoory, Tomer,
86 Berger, et al., 2005; Torralva, et al., 2007). Detailed
87 reporting of all responses on the test is important
88 for determining the cause of the failure to detect the
89 faux pas, and it appears, from studies that report
90 information broken down by question type, that
91 patients make appropriateness errors, that is, not
92 understanding why the faux pas was awkward or
93 inappropriate, and intentionality errors, that is, not
94 understanding that the faux pas was unintentional
95 (Stone, et al., 1998; Torralva, et al., 2007).

96 The faux pas task has been found to be independent
97 of the effects of depression in patients with
98 frontal damage (Shamay-Tsoory, Tomer, Berger,
99 et al., 2005). It has been found to correlate with
100 perseverative errors on the Wisconsin Card Sorting
101 Test, but not with other scores on the Wisconsin,
102 nor with verbal fluency (Gregory, et al., 2002). It
103 also may measure something distinct from emotion-
104 based decision-making, as it did not correlate with

1 performance on the Iowa Gambling Task
2 in frontotemporal dementia patients (Torralva,
3 et al., 2007).

4 *Relationship to Ventral Frontal Damage and TBI*

5 The Recognition of Faux Pas Test has often been
6 used in patients with ventral frontal damage from
7 FTD, TBI, or other causes, and researchers have
8 found that such patients are impaired on recogni-
9 tion of faux pas, but not items testing story compre-
10 hension (Gregory, et al., 2002; Lough & Hodges,
11 2002; Milders, et al., 2003; Milders, et al., 2006;
12 Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005;
13 Stone, et al., 1998; Torralva, et al., 2007). Patients
14 with TBI are more impaired on faux pas detection
15 than either patients with dorsolateral prefrontal
16 cortex lesions, those with more posterior damage,
17 or non-brain-injured controls; they often fail to
18 identify social faux pas, and they erroneously label
19 non-faux pas as faux pas (Milders, et al., 2003;
20 Shamay-Tsoory, Tomer, & Aharon-Peretz, 2005;
21 Stone, et al., 1998). They do not, however, appear
22 to exhibit similar impairments on comprehension
23 of the stories in the task (Gregory, et al., 2002;
24 Milders, et al., 2003; Milders, et al., 2006; Stone,
25 et al., 1998). A longitudinal study showed that
26 patients with TBI were impaired on the Recognition
27 of Faux Pas Test an average of two months post-
28 injury, and remained impaired relative to healthy
29 controls one year later (Milders, et al., 2006). There
30 was some improvement in Faux Pas scores over the
31 year, but this improvement was equivalent in
32 patients and controls. A second longitudinal study
33 looked only at the intentionality question on the
34 Faux Pas test, because that was found to best differ-
35 entiate patients and controls (Milders et al., 2008).
36 Patients with TBI were significantly impaired on
37 the intention question both soon after TBI and at a
38 one-year follow-up (Milders et al., 2008).

39 *Links to Functional Outcome*

40 Faux pas scores were significantly correlated with
41 behavioral disturbances in frontotemporal demen-
42 tia patients, as measured by the NPI, ($r=-.64$,
43 Gregory, et al., 2002). Faux pas scores were substan-
44 tially, but not significantly correlated with behav-
45 ioral outcomes in patients with TBI ($r=-.61$,
46 Milders, et al., 2003), with behavioral outcomes
47 measured using relatives' ratings on the Neuro-
48 psychology Behavior and Affect Profile, a question-
49 naire rating indifference, social inappropriateness,
50 poor communication pragmatics, depression, and

51 mania. However, neither soon after the occurrence
52 of TBI nor at one-year follow-up did Milders et al.
53 (2008) find a correlation between a composite ToM
54 measure including Faux Pas scores and cartoon task
55 scores, and TBI patients' informant-rated behav-
56 ioral problems on three different rating scales.
57 In patients with schizophrenia, Faux Pas scores
58 significantly predict community functioning, and
59 are better predictors than are cognitive measures
60 (Pijnenborg, Withaar, Evans, van den Bosch,
61 Timmerman, & Browner, 2009).

62 ***Conclusions about ToM Tests in Ventral*** 63 ***Frontal and TBI Patients***

64 Of the theory of mind tasks reviewed above, sar-
65 casm detection tasks and the Recognition of Faux
66 Pas Task seem to be the most sensitive to ventral
67 frontal damage and TBI. Both are also correlated
68 with some outcome measures: depression in the case
69 of sarcasm tasks (Shamay-Tsoory, Tomer, Berger,
70 et al., 2005), or behavioral disturbances, in the case
71 of the Recognition of Faux Pas Task (Gregory et al.,
72 2002; Milders et al., 2003, 2008). In contrast, there
73 is no strong evidence that false belief tasks, cartoon
74 tasks, story tasks, the Reading the Mind in the Eyes
75 task, or the Charlie and the Chocolates task are con-
76 sistent sensitive to ventral frontal damage or TBI,
77 nor do any of these measures show correlations with
78 patient outcomes.

79 In order for sarcasm detection tasks and the
80 Recognition of Faux Pas Task to be clinically useful,
81 the next step in research must be to develop popula-
82 tion norms by age, gender, and ethnicity. Without
83 norms to compare an individual client's score to,
84 clinicians cannot tell whether that person is per-
85 forming as expected or is impaired. Collecting
86 norms for various cultures and subcultures is essen-
87 tial when a test measures social inferences, because
88 subtle cultural differences can affect the way social
89 situations are interpreted.

90 Theory of mind tests, however, tap into only one
91 type of social competence. They generally use static
92 stimuli or stories, and as such, are quite different
93 from the demands of a dynamic social interaction,
94 in which information is processed rapidly, online,
95 and comes from multiple input sources, includ-
96 ing dynamic facial, postural, and prosodic cues.
97 Accordingly, other researchers have developed video-
98 based social inference tasks that improve upon the
99 ecological validity of ToM tasks. One promising
100 video-based tool has been developed out of research
101 on sarcasm detection.

1 **The Awareness of Social Inference**

2 **Test (TASIT)**

3 *Description of the Task*

4 TASIT requires emotion recognition and lie- and
5 sarcasm- detection from video-taped stimuli of actors
6 engaged in social interactions (McDonald, Flanagan,
7 & Rollins, 2002). The authors propose that the
8 Emotion Evaluation Test represents an improve-
9 ment over previous emotion-recognition measures
10 because the emotional expressions on TASIT are
11 spontaneous, rather than posed, and the dynamic
12 nature of the stimuli allows for the complexity of
13 real-life emotional expressions, including the natu-
14 ral tendency to regulate or conceal a strongly-felt
15 emotion (McDonald, Flanagan, Rollins, & Kinch,
16 2003). The Social Inference portions of the task
17 consist of short video clips of actors engaging either
18 in sincere or counter-factual exchanges, that is, sar-
19 casm or lies. The context of the statement indicates
20 whether the speaker's meaning is the opposite of
21 what was said (sarcasm or lying), or is sincere.
22 Responses are scored according to four comprehen-
23 sion questions, probing aspects of intention, belief,
24 and emotion (McDonald, et al., 2002). Questions
25 all have yes/no/don't know responses, and are scored
26 as correct or incorrect. Australian norms are avail-
27 able for all three subtests of TASIT (McDonald,
28 Flanagan, & Rollins, 2001).

29 *Relationship to Ventral Frontal Damage and TBI*

30 TASIT was administered to twenty-one people with
31 TBI, and twenty-one age- gender- and education-
32 matched controls (McDonald, Flanagan, Martin, &
33 Saunders, 2004). All measures of TASIT differenti-
34 ated people with TBI from healthy controls, whereas
35 people with TBI had no difficulty with comprehen-
36 sion of literal statements in the social inference
37 sections of TASIT.

38 TASIT performance has also been associated with
39 performance on an emotion-recognition task using
40 photographs, a false-belief task, and a social problem-
41 solving task, showing good convergent validity
42 (McDonald et al., 2006). Measures of verbal and
43 visual memory and working memory correlated with
44 TASIT performance as well, however, suggesting
45 that TASIT relies on basic cognitive abilities as well
46 as socially specific skills (McDonald et al., 2006).

47 To our knowledge, TASIT has not yet been tested
48 in patients with known ventral frontal damage, rather
49 than just a diagnosis of TBI, or in patients with ven-
50 tral frontal atrophy from frontotemporal dementia.
51 We would predict it to be useful with such patients.

Links to Functional Outcome

52 TASIT's relationship with real-life social skills was
53 established by demonstrating an association between
54 TASIT scores and structured ratings of social inter-
55 actions of the participants with TBI (McDonald
56 et al., 2004). Other research has shown that TASIT
57 performance is associated with duration of post-
58 traumatic amnesia and post-injury employment
59 status (McDonald & Flanagan, 2004), and with
60 communication competence (Watts & Douglas,
61 2006). One social skills training intervention, how-
62 ever, did not improve TASIT scores (McDonald
63 et al., 2008).
64

Conclusions

65 Overall, TASIT represents a promising beginning
66 to the development of clinically useful and well-
67 validated measures of social abilities. Across studies,
68 there was variability in both the level and the quality
69 of difficulties exhibited by people with TBI; some
70 struggled with emotions, others struggled with sar-
71 casm/deception inferences, emphasizing the need to
72 have multi-dimensional assessments of social abili-
73 ties (McDonald & Flanagan, 2004), as we have with
74 cognitive abilities. Thus, although TASIT samples
75 two or three domains of social inference abilities, it
76 would be useful to have tasks that assess a wider
77 range of social inferences than just emotion recogni-
78 tion, deception, and sarcasm.
79

**Possible Future Directions for
Applied Social Neuroscience**

80 Social neuroscience has an opportunity to offer
81 tremendous benefits to neurological patients suffer-
82 ing from social deficits, by providing objective ways
83 to define and measure social competence. Many
84 patients with TBI and/or ventral frontal damage
85 suffer long-term consequences to their well-being
86 because of their social deficits, and new develop-
87 ments in this field can help guide clinicians in design-
88 ing effective rehabilitation programs to improve
89 social functioning in everyday life. There has been a
90 lag between empirical developments in social neu-
91 roscience that generate objective, performance-
92 based measures of social competence and clinicians'
93 making use of these measures when assessing social
94 competence. This lag exists partly because many
95 such measures do not have published norms.
96 Clinicians rely on norms to tell them what the
97 expected score on a test would be for a person of
98 the same age, gender, socioeconomic status, and
99 ethnicity. Of the social measures reviewed above,
100
101

1 only The Awareness of Social Inference Test (TASIT)
2 has norms available, for primarily white Australians,
3 though versions of the test are now being created for
4 North American and Dutch clients (McDonald,
5 personal communication, 2010). Clinical assess-
6 ment of patients with TBI or frontal damage instead
7 relies heavily on cognitive performance measures
8 of executive functions, because norms are readily
9 available, while relying on more qualitative or ques-
10 tionnaire-based measures of social and emotional
11 functioning. Clinicians doing rehabilitation, how-
12 ever, are well aware of the need to address social
13 competences, and some treatment programs for TBI
14 address social behavior particularly (e.g., Dahlberg
15 et al., 2007). Social neuroscientists and neuropsy-
16 chologists therefore have an opportunity to increase
17 the application of their research by 1) collecting
18 norms on social competence performance measures
19 developed; and 2) in patient studies, including mea-
20 sures of real-world functional outcome, so that cli-
21 nicians can prioritize tests that predict patients' level
22 of coping in their everyday lives.

23 The purpose of neuropsychological assessments
24 is to make recommendations about a patient's func-
25 tional status. If a test is insensitive to TBI or ventral
26 frontal damage and uncorrelated with patient out-
27 comes, we should be asking ourselves, "Should this
28 test be included in assessment batteries?" There is
29 considerable time and cost involved in neuropsy-
30 chological testing, and patients often find it unpleas-
31 ant, tiring, and frustrating. Therefore, test selection
32 should be parsimonious and the assessments should
33 produce information that has practical, real-world
34 relevance for the purpose of informing treatment
35 recommendations. For these reasons, we encourage
36 researchers and clinicians to work together to inves-
37 tigate the utility of currently used tests, and produce
38 and use new neuropsychological tests that have
39 broad, stratified normative data, empirically dem-
40 onstrated neuroanatomical correlates, and empiri-
41 cally established associations with real-world
42 functional difficulties. Tests that do not meet these
43 criteria should be re-evaluated and possibly dropped
44 from neuropsychological assessments.

45 There are many tests of "theory of mind" in the
46 research literature, such as false belief tests and car-
47 toon ToM tests, for which there is no empirical evi-
48 dence of sensitivity to ventral frontal damage or
49 TBI. In addition, more data linking performance
50 on ToM tests to actual social performance should be
51 gathered; tests that relate to real-world social func-
52 tioning are valuable regardless of whether the tests
53 are sensitive to specific regions of brain damage.ⁱⁱ

54 Despite these problems, two types of ToM tests do
55 seem promising. TBI and ventral frontal damage do
56 seem to impair performance on the Recognition
57 of Faux Pas Task and Sarcasm/Irony Detection tasks,
58 and there are some data linking these tests to func-
59 tional outcomes. As an ecologically valid exten-
60 sion of Sarcasm tasks, the TASIT is promising as
61 a clinical measure of some social competencies,
62 with norms, solid validation, and links to real-
63 world social competence. The scope of social com-
64 petencies that these tests measure, however, are
65 limited.

66 We encourage researchers and clinicians to work
67 together to produce and use objective performance
68 measures of a wide range of specific social compe-
69 tencies, not just the tests of inferring others' internal
70 states reviewed here, but also, for example, the abil-
71 ity to track the intimacy level of the people one is
72 interacting with before disclosing information, to
73 track relative social status and select behavior appro-
74 priately, to monitor reciprocity and fairness in inter-
75 actions, and to understand and act on conversation
76 partner's needs for turn-taking and relevance.

77 For patients' and their loved ones' best interests,
78 neuropsychological assessments should be geared
79 towards creating treatment programs that may
80 include 1) education for both the patient and the
81 family about key areas of loss in competencies,
82 2) adopting strategies to manage any difficulties,
83 and 3) retraining some functions. To improve care
84 of patients with social deficits following TBI and/or
85 ventral frontal damage, rehabilitation programs
86 must have a detailed picture of an individual's
87 strengths and weaknesses in a range of social com-
88 petencies. The TASIT is already available for clinical
89 use. With further research to collect norms and
90 study how tests are related to everyday outcomes,
91 some of the other social competence tests reviewed
92 here could become available for clinical use in the
93 near future, thus improving the assessment and sub-
94 sequent treatment of social dysfunction following
95 brain damage. Patients and their families would
96 benefit enormously from such progress in social
97 neuroscience research.

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