Neuropsychological Areas Assessed By Tactual Formboard Test

The NAAVI text consists of a book that reviews all facets of neuropsychological assessment of individuals with visual impairments. The NAAVI subtests, as well as other tests not contained in the NAAVI, are reviewed. The book shows how these subtests provide information about each area to be assessed and gives the examiner specific things to observe and consider when interpreting findings. Besides for yielding scaled scores, the NAAVI also provides a great deal of qualitative information that help form a complete picture of an individual's functioning.

It is important that the examiner has a thorough understanding of assessment of individuals with visual impairments and how to assess in each of those areas, which the book provides. The following excerpts represent a sample of the information provided within the NAAVI book about neuropsychological domains for which the Tactual Formboard Test can be used to assess. As the examiner considers each of these areas, he or she can look to Tactual Formboard Test performance to obtain information about that area of functioning.

Chapter 11
Spatial Ability

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Exploration

Some tests, such as the Purdue Pegboard and Digit Symbol, require the examiner to orient the individual to the test materials, even guiding the individual's hands to the appropriate parts of the test while explaining the parts of the test, and the procedure. With other tests, such as Object Assembly and Tactual Formboard, the subject is left to do exploration on his or her own, and this can be observed. It might be noted that with the Tactual Formboard, the time to last row is taken as a formal measure of exploration (see Appendix III). That is, it is advantageous for the individual who is introduced to this test to feel the entire board in order to know what he or she is dealing with. Surprisingly, this is rarer than would be thought. Individuals, even without neurologic damage, will take an excessive amount of time before exploring the part of the Tactual Formboard that is farthest away from them.

Some individuals seem to naturally explore space. These are the individuals who will ask the examiner about the room, and other questions to orient them in space and to understand the space they are in.

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Testing of Spatial Understanding

The Tactual Formboard Test (see Appendix III) approaches the question of spatial understanding in a variety of ways. First, as mentioned above, the exploration of space can be observed easily, and the measure of time to last row is a numeric representation of part of this process. During this process, it can also be observed whether the individual attempts to understand the shape involved, and to match it to the same shape receptacle. This sounds straightforward, but some individuals simply use a trial-and-error method, moving the piece around the board, hoping it will go in. When the individual finds the intended receptacle for the piece, it can be observed how well the individual is able to rotate the piece in space, and understand this orientation in space, in order to get the piece in the slot. It should be noted that it is possible for the individual to rotate the piece in space, without sufficiently understanding what is going on. For example, turning the circular piece around and round to fit it into the wrong slot seems to suggest a poor understanding of how a circular piece and a circular slot would fit together. Improvement of speed on this task, between trials and within trials, can be taken as learning. For example, learning the layout of the board, and demonstrating an increased understanding of the spatial relationships involved indicates learning is occurring. There are five trials to the Tactual Formboard Test. After the third and fourth trials using both hands, memory for the shapes and their locations are tested. If the individual cannot name a shape, he or she is asked to describe the shape or draw it in the air. The mapping and understanding of the shapes soon becomes evident.

The fifth trial, the rotated trial, is very directly related to understanding space. The memory for shape and location, after the fourth trial, should give a good idea as to how well the subject has made a mental map of the shapes and their locations. On the fifth trial, the board is rotated 90 degrees, with the subject's hands on the board, so that the nature of the rotation can be understood before beginning the trial. Then, it can be seen whether an individual can rotate a mental map, if one was made, in order to approach this task. It is common to observe the individual struggle with the first two, three, or four pieces but then seem to catch on. Observing their movements, it usually becomes clear if they are using the mental map they made in a rotated way. Presumably, this will translate to how well an individual can understand a building, of which he or she has made a mental map, after coming in

a door on one side of the building, then coming in a different door on another side of the building. Is he or she still able to use the map he or she has made?

Hollins and Kelly (1988) attempt to assess knowledge of a layout from a different angle, They have individuals learn a layout of objects on a circular table, and then see if they point out the objects from a different side of the table. This seems straightforward, but the use of a pointer raises the question of whether the subject understood the line it was pointing in.

The Tactual Formboard Test appears to be especially important for the individual who has a compromised sense of space for one reason or another. It is common to see individuals with brain injuries, particularly to the parietal lobe, have a great deal of difficulty with this task. With these individuals, the importance of having five trials and two memory phases becomes apparent. An individual who starts out getting only three or four shapes in the board in the eight-minute time limit, for example, and then continues to have poor performance and poor memory of shapes and location, is likely to do very poorly in spatial-oriented tasks such as mobility/travel and cooking in the kitchen. This assessment provides normative scoring for a measures of how well an individual is able to adjust to the space around them (Adjustment to Space), to what degree they explore their surroundings (Exploration of Space), and spatial memory (Spatial Memory). The procedures for obtaining these scores in described in Appendix III.

Poor performance on location recall, combined with poor performance on the Thoroughness portion of the Pattern of Search, predicts those who will not likely be independent travelers (See Appendices III and VII). However, some individuals with similar brain injuries, who start out just as poorly but are able to show improvement, especially in the later trials and on the memory and location portions of the test, will receive different rehabilitation recommendations. For the first individuals, the likelihood that they would ever be independent travelers is slim, and training should take that into account. For the second group of individuals, even though they are having difficulty in their travel training, the teacher should be encouraged to continue, as they have shown improvement in spatial understanding with enough exposure.

Chapter 12
Spatial Learning and Memory

Spatial learning and memory is roughly equivalent to visual learning and memory for the sighted population.

However, memory for movements play a larger role in spatial memory for the person who is visually impaired. That is, observing the subject's movements tells something about a movement memory, or sense of distance and location memory, when this occurs over time. For example, on the Purdue Pegboard Test the individual has to move his or her right and left hand to find the well that has the pegs in it. On the assembly portion of the test, there is more to remember in that there is a well for pegs, for sleeves and for collars. Depending on how the person approaches the test, there may be memory for where the next hole is, to put the assembly. That is, if the person is using a two-handed method, as is encouraged, spatial memory is needed to remember the location of the next hole. With the Tactual Formboard Test, movement/spatial memory can be involved on the single-hand trials.

Tactual Formboard Test

The Tactual Formboard has its own memory trials (see Appendix III). After each trial, using both hands (trials 3 and 4), there is a memory assessment for recognition of the shapes (content) and their locations. Note that memory for the Tactual Formboard is mediated by verbal memory, as well as spatial memory, due to a need to verbally recognize shapes. Should the individual do poorly on the second memory for content and location, that is, less than five memory for content and less than four memory for location points awarded, further assessment could be done. Testing the limits trial could be used, which is not part of the standardized Tactual Formboard Test. That is, the individual could be presented with the completed board, in order to study the shapes and locations, then a memory for content and location trial could be done for a third time. Note that if this procedure is used, comparison of the rotated trial to the normative values would be quite different, as the testing of limits was not included in the norms, before the rotated section was used. However, if location memory is very poor after the second memory trial, the idea of rotating a mental map would not apply, as the map was not established. For this reason, the rotated trial is often left off, as without a mental map, it loses interpretive value.

Mangiameli's Tests (Mangiameli et al., 1999, Mangiameli & Peters, 1999, Mangiameli, 2003) have a version of the Tactual Performance Test that is similar to the Tactual Formboard Test, but has one memory trial for content and location and no rotated trial.

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Chapter 13
Spatial Distortion

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Instruments to Assess Spatial Distortion

There are other tests that can give information about understanding of spatial areas that are more structured than the Pattern of Search Test. This is particularly true of the Tactual Formboard Test and the Pattern Board Test. The Spatial Pattern Recall and the Haptic Memory Recognition Test may also contribute to this. The Block Design Test from the Haptic Intelligence Scale is not as useful, in this regard, as such a small area is used. Mangiameli (2003) has a test called the Tactual Search Board that is large enough to be able to observe which areas of space are not receiving attention.

The Tactual Formboard Test is a very useful test of spatial distortion, as problems can be seen both in the performance portion of this test, and in the memory portion. During the performance portion of the test, individuals might try to put the shapes in on one side of the board, tending to ignore the other; or will ignore portions of the board such as far right, far left, close center and so forth. During the memory portion of this test, there are no slots to guide the placement of the pieces, and they are placed on the board as the subject remembers them. It can then be seen if the subject crowds the pieces over to one side or another or, quite often, close to the subject. If all the pieces are crowded close to the subject, it represents shrinking of space. Individuals will often confirm they have a conception of space, where they might be leaving a room, and think they have reached the door well before they have. Or, they may search for things, and simply not reach far enough. Individuals who demonstrate shrinking of space, on the test, can also be observed to do this more than others in everyday situations.

The Benton Visual Retention Test (Strauss et al., 2006), for sighted individuals, can be scored for errors on the right, or left, side. The Pattern Board Test might be considered roughly analogous to this, in that it can be observed in the reproductions from memory as to the right and left side; and that there seems to be a predominance of errors on one side or another, to a significant degree. Or, it might happen that the whole remembered pattern is shifted, in some direction, from the original. Such anomalies on one pattern is likely not meaningful. Repeated errors of a consistent type are what are noteworthy.

Spatial distortion is certainly not seen in every visually impaired person, but when it is, it is important to understand. Then, the individual, and the people working with the individual, can compensate for it, based on feedback from the examiner. When individuals are told of their spatial distortions, revealed by the testing, they often recognize on their own how this has been evident in their daily lives.

Clinical Example

A 71-year-old man had no vision in his right peripheral field, due to left-hemisphere occipital, ischemic stroke. His left visual field was intact with adequate acuity. He still did some work on the farm, including driving a pickup. At first, he appeared to neglect his right side, as he would run into a ditch or bump into things, on his right side. With practice, he learned to scan to his right. This gentleman took the Tactual Formboard Test and the Pattern of Search Test, blindfolded. He was slow, but able to complete the Tactual Formboard Test on each trial. He was able to use his right hand. However, for each trial, he tended to explore the right side of the board only after he had filled in most of the left side. The Pattern of Search Test results were more dramatic, and could be interpreted as indicative that there was still a tendency to neglect the right side of his space. He displayed a good search strategy, by searching back and forth across the page with close, parallel lines. However, there were almost no lines made in the right side of the page. Notably, he held his pen in his right hand, to search. It would appear that an underlying spatial neglect of the right side was still present, in spite of his ability to adapt.

Chapter 18
Motor Testing

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Coordination

Observations of an individual's coordination with each hand, and bimanual coordination and cooperation can be observed. Use of the hands together can be observed with the Tactual Formboard Test and the Purdue Pegboard Test. The Tactual Formboard Test is also useful in observing movement memory with the single-hand trials. Coordination can be assessed in the usual ways; for example, with fingers to thumb movements, rapid finger touching, and rapid alternating movements (diadochokinesis). A test of rapid alternating movements, commonly

used, is having one hand with palm touching the table, while the other hand is a fist touching the table. The individual is instructed to alternate in quick succession.
The coordination of these movements can be related to prefrontal motor organization, as well as cerebellar functioning. That is, presuming that the basic motor abilities are intact. When testing for motor abilities, it might be also a good time to slip in a go, no-go task.

Appendix

Interpretation:
It can be seen from the normative tables that the general population of individuals with visual impairments, in Michigan, performed better in all ways on the Tactual Formboard Test as compared to the sample of mixed neurologically-compromised, visually impaired people, and the sample of adults who are born with very low birth weight and visual impairment. So, the question can be brought up as to what specific functions are compromised in the latter two groups. A number of possibilities come to mind.

First of all, it takes a certain amount of sustained attention and persistence to perform well on this task, which can be lengthy, in terms of time, for many. It might be expected that if sustained attention or persistence problems are present, performance would tend to fall off as time goes on. Individuals doing substantially worse on the second trial with both hands, than on the first would raise the question of poor sustained attention or persistence, or perhaps fatigue. Of course, some individuals might become irritated with the lengthy and repetitive nature of this task and either refuse to continue or start performing poorly. This has happened very infrequently.
The test taker's haptic ability to identify the shapes, and match them to their same shape receptacles, would seem crucial to this task unless the individual was using the trial-and-error approach. During the memory phase, it should become clear as to whether the individual was able to identify shapes during the test. True, an individual might be able to guess at some of the shapes, such as circle, square, and triangle, even if unable to identify them; but this seems to be a very rare occurrence. Should there be some doubt about the individual's ability to identify the shapes, this could be assessed at the end of the test, by laying all the shapes out in front of the individual, and saying, **"Find the star. Find the triangle,"** etc**.** Should more detailed information about the individual's ability to identify shape be needed, the Haptic Sensory Discrimination Test (Dial, Mezger et al., 1991) could be given.

It is quite common to find individuals who appear to understand the shape they pick up and manipulate, but

are not able to match it very well to the slot that it goes in. This would indicate that the basic ability to do tactual identification is intact, but is not highly developed. A person of average intelligence, normal tactual sensitivity, and an intact spatial sense should be able to match the shapes with their receptacles without a great deal of trouble. In discriminating what the shapes are, the cross and the star are often confused, and the hexagon is rarely recognized as a hexagon. Should an individual have no difficulty with these three pieces, they would be considered above average in the haptic discrimination of shapes.

The executive function of planning an approach to the task, or strategy, seems essential for a good performance. The measure of how long it takes an individual to explore the last row of the board (the back row of the board farthest away from the subject) seems to offer some information as to a person's ability to develop a strategy to approach the task. Surprisingly, very few individuals in the entire sample explored the board before picking up the first piece. So, if the individual does, this would place that person above average in terms of developing a strategy to approach the task. Also, related to executive function is the ability to adapt and shift. Some individuals can be noted to perseverate on a wrong choice, attempting to get a piece into an erroneous slot without moving on. This perseveration can be taken, as any perseveration is, as possibly symptomatic of neurologic impairment. Other inabilities to shift, such as the inability to change strategy if one did not seem to be working,, are not as diagnostic and may relate to psychological, rather than neurologic, factors.

A major reason for developing this test is to assess spatial understanding and spatial learning and memory. Spatial understanding can be shown in several ways. The individual typically has to rotate the piece in space in order to fit it into the slot (the circle is an exception here). Some individuals do not seem to understand the need to rotate, or understand rotating in space itself. This appears to be particularly true of the low birth weight individuals. This appears to get at what, in vocational tests, might be called *spatial relations*, or knowledge of how an object moves in space. For some individuals, there may be some imagery involved in doing this type of task. Spatial understanding also extends to the test as a whole. Thus, if the individual is going to do well in comparison to the norms and improve from trial to trial, understanding of the objects, and how they fit into the space of the board, is essential. Of course, knowledge of the space of the board is assessed by the first and second location memory trials. Problems in memory for location can be hypothesized to go along with parietal lobe deficiencies. Individuals with anoxic damage to the brain seem to be hard hit in this area. It should be obvious that learning location in space is invaluable for visually impaired individuals. Location

memory scores for the second location trial, below five, would indicate difficulty with this type of understanding and memory for location. Scores below three would indicate marked problems. The individual who cannot improve from trial to trial, being unable to get all 10 pieces in and whose memory for location is profoundly impaired, is likely to be lost in space. These individuals will likely never be independent travelers, other than with precise door-to-door service.

It might be noted here that TFBT memory for location has some similarities to the Pattern Board memory from the Haptic Intelligence Test (Shurrager & Shurrager, 1964) and the Spatial Pattern Recall from the Cognitive Test for the Blind (Dial, Mezger et al., 1991). It can be hypothesized that the Pattern Board would be the easiest of the three tests to use verbal encoding to assist spatial memory, while Spatial Pattern Recall and the Tactual Formboard Test Memory would be harder to verbally encode.

The advantage of the Tactual Formboard over these other tests is that it is a learning process, with repeated trials, rather than a single trial for each memory item on

the Pattern Board and Pattern Recall Tests. This becomes particularly valuable for an individual with impaired performance on the Tactual Formboard Test. A very substandard performance, with no improvement over the five trials and two memory sections, is a much different picture than that of a person giving an initial impaired performance, who gradually improves over time. In other words, results from the TFBT can demonstrate that with repeated exposure and efforts at learning, learning of space is possible for some individuals and much more difficult for others, even if their initial performance was virtually the same.

Interpretation of the Rotated Trial is possible if the memory for Location 2 performance is good enough to discern that the individual has made some mental map of the layout of the board. Then the interpretation is based, not only on the speed, but the observation as to whether the individual appears to be have rotated the map in mind to enhance performance. If the individual simply searches around, with every piece, without attempting to go to a remembered location, then no rotation of a mental map has taken place, no matter how fast the performance. This ability to understand space from different directions is important for functioning in a variety of situations; for example, understanding the layout of the furniture in a room. Is it understood when coming in a different door into the room than usual? Or, the layout of a building; is it understood from one door to another? Or the layout of a city; is it understood from one street to another? Taken as a whole, individuals who do well on the Tactual Formboard

Test will do well in classes, such as travel training and kitchen skills. The opposite also appears to be true for those who do poorly on the test. These individuals are likely to do poorly in these areas.

One feature that can be observed during the Memory and Location trials is how the individual groups the pieces on the board that are recalled. There seem to be natural individual variations as to how much an individual will shrink space in this endeavor. Observation and questioning of individuals who tend to group the items close to them, disregarding the farther reaches of the board, reveals that they do tend to shrink space in other contexts. For example, after being in a room, if the individual turns around and wants to leave by the same door, the individual will think they are at the door well before they are; thus, shrinking space. This is not necessarily a hallmark of a neurologic problem, but rather seems to be an individual variation among people.

The TFBT has been used for individuals who are losing their sight, and are concerned about how well they will function when they are completely blind. Most individuals, in this situation, will gladly take the test under blindfolded conditions. Their performance on the test can give them some sort of indication of how well they might do in terms of understanding space, and remembering space, once vision is lost. Using the test in this way is typically very appreciated by the person in this situation.