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Cognitive world: Neuropsychology of individual differences

Alfredo Ardila[a] and Monica Rosselli[b]

[a]Communication Sciences and Disorders, Florida International University, Miami, Florida, USA; [b]Psychology, Florida Atlantic University, Boca Raton, Florida, USA

It is proposed that depending upon the specific pattern of cognitive abilities, each individual lives in an idiosyncratic "cognitive world." Brain pathology can be associated with some disturbed abilities, and frequently experiential changes (i.e., how the world is understood) are observed. Because these patients often are aware of their intellectual changes, they may represent excellent models to illustrate the diversity of cognitive interpretations an individual can have about the surrounding environmental conditions. Four neuropsychology cases are presented to illustrate this point: (a) prosopagnosia associated with spatial agnosia; (b) Gerstmann's syndrome; (c) dysexecutive syndrome due to a head injury; and, (d) patient with Capgras' syndrome associated with a left temporal cyst. It is further emphasized that non-brain damaged people present an enormous—but usually overlooked—dispersion in different cognitive domains, resulting in specific and idiosyncratic patterns of cognitive abilities. It is concluded that the concept of "cognitive world" in neuropsychology can parallel the concept of "perceptual world" introduced by von Uexküll in biology, which assumes that different animal species live in idiosyncratic perceptual worlds, available and knowable by the differences in their sensory system abilities. That is, different individuals live in idiosyncratic cognitive worlds, owing to their differences in cognitive abilities.

Keywords
Capgras' syndrome; cognitive world; dysexecutive syndrome; Gerstmann's syndrome; individual differences; prosopagnosia

Introduction

The analysis of individual differences has attracted no more than a modest interest in neuropsychology (Hartlage & Telzrow, 1985; Vernon, 1994), by reason of the underlying assumption that cognitive abilities are similar across normal individuals. Disregarding the existence of significant individual differences in the patterns of cognitive abilities (Fillmore, Kempler, & Wang, 2014; Halpern, 2013; Maltby, Day, & Macaskill, 2007; Sternberg & Sternberg, 2016), norms in cognitive testing implicitly presume some cognitive homogeneity in normal populations.

In psychology, it has been established that people have quite different patterns of intellectual strategies and cognitive abilities (e.g., Chamorro-Premuzic, 2007; Zhang & Sternberg, 2005). Consequently, it can be speculated that each individual understands and interprets the world in a separate way; they live in different "cognitive worlds," and have distinct worldviews ("*Weltanschauung*").

The concept of "cognitive styles" has frequently been used to identify individual differences in cognitive strategies. Cognitive style refers to the specific way an individual perceives, thinks, remembers, and processes incoming information (Allinson & Hayes, 1996). Cognitive styles represent heuristics individuals use to process information about their environment. These heuristics can be identified at multiple levels of information processing, from perceptual to metacognitive (Kozhevnikov, 2007). Cognitive styles have often been used to refer to the psychological dimension "field dependent vs. field independent" (Witkin, Moore, Goodenough, & Cox, 1977). The core meaning however, regarding the concept of "cognitive styles," refers to the preferred cognitive strategies used by the individual to cope with different living conditions.

The concept of "cognitive world" is by any means partially coincidental with the idea of "cognitive style." We are proposing, however, that "cognitive world," refers to the experiential dimension of cognition, to the worldview (*Weltanschauung)* resulting from the specific pattern of an individual's intellectual abilities; whereas the idea of "cognitive style" emphasizes that there are different problem-solving strategies. For instance, Richardson (1977) proposes the dimension "verbalizer-visualizer" as a basic cognitive style dimension, emphasizing that people use different problem solving strategies. Many years later Oliveri et al. (2012) analyzed the relationships between the preference in use of visual-verbal cognitive representation strategies and lesion site in patients with acquired brain injury. The Visualiser-Verbaliser Questionnaire and the

CONTACT Alfredo Ardila ardilaa@fiu.edu Florida International University, Communication Sciences and Disorders, 11200 SW 8th Street, AHC3-431B, Miami, FL 33199, USA.

Questionnaire on Visual and Verbal Strategies were administered to 48 patients with brain damage. Results showed that the preference for verbalization decreased in patients with a parietal focal lesion, who tended to use a mixed cognitive style. Patients with subcortical bilateral lesions verbalized more than patients with no lesion or right focal lesions. The authors concluded that damage in a specific area associated to a type of cognitive strategy may compromise its use, but does not lead to its complete extinction. But the important point that should be emphasized is that the concept of cognitive style refers to the *preferred cognitive strategies in problem-solving*, not to *the experiential dimension of cognition.*

Few studies have approached the analysis of individual differences in specific cognitive abilities in neuropsychology. For instance, King and Just (1991) analyzed the individual differences in working memory responsible for differences in syntactic processing. Wilson et al. (2002) suggested that changes in cognitive function in old age primarily reflect person-specific factors rather than a developmental process. Bishop, Aamodt-Leeper, Creswell, McGurk, and Skuse (2001) suggested that individual differences in neuropsychological maturity could account for differences on the performance of the Tower of Hanoi in children aged from 7 to 15 years. Kane and Engle (2002) analyzed the role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence from an individual-differences perspective. Friedman et al. (2008) proposed that individual differences in executive functions are almost entirely genetic in origin. More recently, attempts have been made to connect neuropsychological test performance with neuroimaging to understand the brain basis for normative variance in cognition (Gess, Fausett, Kearney-Ramos, Kilts, & James, 2014). McDaniel and Einstein (2011) suggest the aging decline in frontal systems is particularly important to explain individual differences in prospective memory tasks that require planning and strategic monitoring. Frontal lobe damage, on the other hand, is clearly associated with disturbances not just in cognition, but also in controlling cognition, that means, metacognition (Ardila, 2016a; Mazzoni & Nelson, 2014).

Thus, individual differences in specific cognitive abilities have been clearly recognized (Temple, 2014), even though an integrative perspective of these differences is not readily available yet.

Brain pathology can represent a provocative model for studying individual differences in neuropsychology. Brain damage can result in specific patterns of preserved and impaired cognitive abilities. It may be conjectured that patients with brain pathology live in quite idiosyncratic "cognitive worlds." For instance, a person deprived of language due to aphasia or an individual who is unable to recognize places as a result of a right parietal-occipital lesion, has a rather different understanding and interpretation of the surrounding world. Patients with focal brain pathology are frequently aware of the changes in cognition, and can compare their current cognitive conditions with their previous ones. However, the link between brain pathology and cognitive and behavioral changes sometimes is not clear; for instance, Dronkers (2000) has observed that around 40%–50% of patients with lesions in Broca's are do not present signs of Broca's aphasia, while 15% of the patients with the diagnosis of Broca's aphasia, have no injuries in that area.

In this article four neuropsychology cases are presented to illustrate this point: (a) a case of prosopagnosia associated with spatial agnosia and lack of affect for visual stimuli; (b) a case of Gerstmann's syndrome with severe acalculia; (c) a dysexecutive syndrome due to a head injury; and finally, (d) a patient with Capgras' syndrome associated with a left temporal cyst. Personal reports will be included. To extend the idea of "cognitive worlds" to normal populations, an analysis of individual differences in neuropsychological test scores will be further presented.

We are aware that potentially other more illustrative cases of brain pathology associated with changes in the "cognitive world" could be found. We selected these four cases because of the following reasons: (a) they represent quite diverse types of brain pathologies and quite different types of changes in the cognitive world; (b) all the four patients were aware of their current condition; and (c) they explained their internal experiences (cognitive world) in a quite clear, understandable, and overt way. This last condition is not easy to fulfill.

Prosopagnosia and 'visual hypoemotionality'

The patient is a 58-year-old man with a college level education. Prior to the accident, he owned a cloth factory. He sustained a severe head injury in a car accident and presented bilateral basal temporo-occipital hematomas, which were surgically drained. Upon recovering consciousness, he was found to have a severe prosopagnosia and topographic agnosia (for a full report of neuropsychological findings see Lopera & Ardila, 1992; Bobes et al., 2003, 2004). From the onset, it became clear that in addition to his visual agnosia the patient also described an inability to endow visual perception with emotional feelings. The patient reports this experience in the following way:

> My problem is that I lost the knowledge of faces and my spatial orientation. Initially after the accident I needed a

person to guide me through the streets, otherwise I was completely lost. I was hoping this was transitory since I was expecting my condition to improve over time, but soon I discovered that as the days and months passed by my problem remained. The inability I have to recognize people by their faces and to orientate in space are horrible limitations and very serious problems for me. After the accident, everyone seems unknown, unfamiliar; including my wife and my children. To recognize someone, I have to listen to the person's voice. Everyone is unfamiliar to me until I hear them talking. If I see pictures of people, they don't mean anything to me. I only see one nose, two eyes, and one mouth. I know it is a face, but I cannot state whose face it is, or the person's age. I cannot recognize the age of people unless the person is a child or an older person and I hear their voices, because I see the differences there are between them. Otherwise it is impossible for me to establish someone's age just by looking at the face. I can distinguish races, but age is only by the voice. I am capable of the identification of the face gender looking at specific factors such as the length of hair (assuming that almost always males have short hair) or the presence or absence of moustache. For example, if the face has a moustache, I automatically know that it belongs to a male. But someone without a moustache, I won't be able to know if he/she is a male or a female unless I hear the voice.

In relation to animals … I am not sure. If you show me a tiger and a lion, I won't be able to distinguish them. However, birds are different because they have the particularity of flying. But if it is a fowl, I won't be sure what animal that would be. The truth is, that the problem I have with faces extends to animals too. I also have difficulties in identifying models of cars and shirt designs—that is my profession.

Flowers to me have lost their essence; I fail to see them as part of nature. They have become almost synthetic, artificial. It seems to lack a kind of knowledge, no, it's not really a knowledge, rather a certain clarity to see nature itself. I fail to see the flower in all its authenticity. With landscapes, is as with flowers, there is also emptiness in landscapes. I cannot appreciate them; I cannot grasp the beauty of nature. I lack a kind of lucidity in my vision that would normally allow me to appreciate it; its colors, the temperature of its colors so to speak. I cannot think of a right word to explain it. I just cannot enjoy that sense of beauty that nature brings. I cannot distinguish beautiful from ugly things. There is a lack of feeling to what I see.

Both my sense of smell and my hearing have become more sensitive, and this has been of some help to identify people, but at the same time it is also problematic. I have become very sensitive to unpleasant odors. With regard to hearing, no matter how low people speak, I can hear what they are saying. But it's not only that it has become more acute. I seemingly have become more sensitive to detecting other people's emotions by the tone of their voices. I can tell when they are feeling uneasy. I think this is all due to an increased sensitivity in my hearing. Regarding taste, I have to keep asking what I will be eating; since, with the exception of common food such as potatoes, yucca, I am capable of recognizing them, but with infrequent food I have difficulties and I need to be told what I am tasting.

This patient is clearly aware and shows critical thinking of the diverse cognitive changes occurring after the brain pathology. He describes his current way of perceiving, understanding and reacting to the external environmental conditions. Most changes are related with the significance of different sensory information, particularly but not only, visual information.

Gerstmann's syndrome

The patient is a 55 year-old, right-handed male, monolingual native Spanish speaker with high-school level education. Prior to his cerebrovascular accident, he worked as a successful businessman and prestigious politician. Twenty-eight months before the neuropsychological examination he suddenly lost language production and understanding. Brain MRI showed an ischemic lesion involving the left angular gyrus.

For several days following the event he was unable to speak and his level of language understanding was significantly reduced. Except for a mild right facial droop no other significant motor impairment was noted. Speech therapy was initiated and overall his language improved, although remaining with significant word-finding difficulties and paraphasias. Substantial difficulties were evident in discriminating antonyms, such as up-down, open-close, to go in-to go out, before-after, and over-below (for a complete description of this case, see Ardila, Concha, & Rosselli, 2000). In addition, he reported important impairments in understanding numbers and using numerical concepts in the following way:

> I do not understand numbers, particularly long numbers. I do not understand their meaning—is like they not inform me anything. When I see or listen to numbers, they are a mess. For instance, the phone numbers are very confusing. When I listen to phone numbers I do not know what indeed they do mean. Money has also become extremely confusing for me. When somebody tells me about money, I do not understand well if it is too much or too little. Of course, I cannot use money and my wife is now handling all the financial issues at home. I do not comprehend dates or years very well either. I am not sure about the correct number I have to say when somebody asks me about my age or the day of the month. Numbers simply do not have meaning. It is like they had become meaningless words. I am not sure what do they refer to.

The comprehension of quantities of any type was impossible for this patient; he did not understand the meaning of large or small quantities, nor understand money, dates, or age. Any type of information with a numerical representation was impossible for him. In other words, there was a particular conceptual dimension of the world that was lost; consequently, his understanding and interpretation of the surrounding conditions (cognitive world) became rather different.

Dysexecutive syndrome

Patient is a 39-year right-handed man who had graduated from medical school. After working as a physician for a few years, he decided to become a Catholic priest. As a priest, he devoted the majority of his time to teaching, religious guidance, and writing activities. His papers primarily dealt with religious and philosophic topics, reflections about the meaning of life, ethics, and human behavior. While riding a bicycle, he fell down, briefly lost consciousness, and presented a post-traumatic anterograde amnesia for about an hour. When he was taken to a local hospital, a CT scan disclosed a left fronto-temporal fracture with associated edema.

Approximately six months later, he was referred for a neuropsychological exam because he complained about attentional difficulties, mild memory deficits, inability to understand his readings on philosophy, and lack of interest toward his work. He described his current condition in the following way:

> I remember that only some two hours after the accident I realized about the situation. That is, that I had suffered a trauma. Apparently, I lost consciousness for about 30 minutes. For the next one-hour and half, I only have some fragmentary memories. For instance, the journey to the hospital in the ambulance. Four hours later I was vomiting in two opportunities. I remember that I had a very severe headache at the hospital.
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> Initially, I did not care about the body damage I had suffered. I only listened that the physician said I had some brain edema. I was quiet, and although my left face was deformed, I did not care about it. I supposed it was due to the edema in my left eyebrow. I remained hospitalized for about one week.
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> About one month after the accident, I returned to my usual activities and I began to celebrate the Mass. However, I got very confused. For instance, I didn't know if I had already read or not the gospel; if I had or not performed a particular step. Somebody else had to be with me all the time, in order to help me and to indicate me what should I do. By the same token, in the everyday life I began to do something, and then I moved to another activity, and another, and another without finishing any one—when I realized I had begun three or four different things simultaneously. Moreover, sometimes I began something, and then I wondered what for I was doing it. Or just I forget what I was going to do.
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> Since the first weeks, I permanently felt a great somnolence. I suppose it has now decreased, but anyhow, it remains. In my community during the morning, we spend half an hour in meditation and half an hour in reading. Meditation was impossible for me. I didn't know what to do during this time, and I felt it was non-sense and terribly boring. I couldn't read either, because it was totally non-interesting to me. If I tried to read, I did not retain anything at all. In addition, I did not feel any interest toward current news and events, and I preferred simple activities such as to watch TV, particularly soap-operas and easy programs. I never before behaved in such a way.
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> About 40 days after the accident, I realized I did not feel any interest toward my work activities. I felt a complete indifference. Not because I did consider these activities were not valid or important, just they did not have any affective interest for me. When I have tried to lecture and teach, I cannot organize a sequence of ideas in my head. When I have tried to write, my writing has not any clearness and it is totally confusing. I skip logical steps in the redaction, and additionally, I make many orthographic mistakes. I feel a permanent slowness in all my intellectual activities. When reading or writing, I cannot identify what is the central issue or idea, and how to develop and analyze it.
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> I used to read and to write a lot about ethical issues. After the accident, when I have tried to read books about ethics, I feel that it is non-sense and silly. Why to be so harsh and strict? I cannot understand the reasoning. Of course, I know they are right.
>
> During the second month, I realized I did not have any initiative. Usually, I had been used to be a sort of leader. I used to be all the time looking for new activities and programming new work. When I visited another city, I immediately phoned my friends. I was always advising my friends and pupils about new interesting books to read. Now, if my friends phone me, it is O.K., but I do not look actively for them. Furthermore, I always felt very excited when somebody I love phoned or visited me, for instance, my mother. Now it is quite different; when my mother phones me, I do not feel the same affection I had before. In a certain sense, I do not care. Now, when I am with some very good and close friends, I do not feel the same emotional relationship I had before. I feel they are far away.
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> I studied and graduated at the Medical School in Bogotá, and worked in Bogotá for several years. So, I know the city quite well. However, when I first arrived to Bogotá after the accident, I felt as if everything were very far away in time. It is difficult to put it in words, but it is as if memories were too far away in time. I crossed by the Faculty of Medicine where I spent lots of time. I recognized everything, but it was as if it

had been there a very, very long time ago. I feel things and memories as strange to me.
About three months after the accident, I realized that my temperament had changed. I used to be a very tolerant and easy-going person. I began not tolerating jokes and I strongly reject any reference to me. I become really mad, even with my community superiors. I liked to paint, especially landscapes. I never have been a real painter, but anyhow, I enjoyed it and it was for me a great hobby. Now, I take the palette and I do not know what to do next. I think I don't enjoy landscapes as before. I feel things as far away and alien. It is a sort of indifference.

Four months after the previous self-report, the patient returns for a follow-up exam. He emphasizes that his attentional span has improved. However, his affective changes (indifference to people and to professional activities) have remained as previously reported. He feels that religious conferences he has attended have been too boring and detailed, and he does not understand the purpose of devoting so much attention to little and irrelevant things; this has been particularly true with regard to ethical issues. Additionally, he has had some difficulties following the community timetable; he states that he cannot understand why it has to be so important to begin the activities at a particular time. The patient mentions he understands it is right to follow a timetable, but it is disgusting for him. He feels better, but he has observed that his sexual drive and fantasies have increased and this has been particularly embarrassing for him, although he assures he never has presented any inappropriate behavior with women. The patient mentions that he has begun to smoke again (he had been a smoker only during his university years) but, he supposes, this is for increasing his level of attention (and during the exam he begins to smoke). He has observed that money (and in general, according to his words "material things") has become very important for him (before the accident, he was a "spiritual-oriented person," not especially concerned with money). He emphasizes he has become interested in concrete and not abstract things. He mentions that he has even considered the possibility of leaving the religious community. Additionally, before the accident, he strongly liked classic music; now, he evidently prefers popular and dancing music.

This report is particularly illustrative of the diversity of changes in the patient's understanding and interpreting the world; the value system (what is and what is not important and significant) has dramatically changed after the accident. Certain changes should be emphasized: difficulties in controlling attention, impairments in the ability to conceptualize, emotional changes, temporality of behavior, and social relationships.

Capgras' syndrome

A 31-year-old male, final year law student consulted a physician because of depression, headaches and adynamia. On occasions he reported nausea. The EEG showed high theta activity level in the temporal areas at the end of hyperventilation, but without a true paroxystic character. A diagnosis of depression and headaches caused by stress was made. During the following months, the patient consulted different psychiatrists and psychologists because of these symptoms. He followed short therapy sessions and took antidepressants (for a full report of this case see Ardila & Rosselli, 1988).

Some months later, he presented partial elementary motor seizures of the right upper limb and face. At times, there was sudden anacusia without loss of consciousness. Rivotril was prescribed. EEG showed minimal, nonspecific anomalies in the left hemisphere and occasional bursts at the same frequency but without a true epileptic character during hyperventilation. Tegretol (600 mg/day) was prescribed. About one month later, a generalized tonic-clonic seizure set in. One month after that, a new EEG was taken, this time under sleep deprivation. It appeared quite abnormal, showing theta activity bursts intermixed with acute elements in the left temporal regions. At times, there was continual theta activity which became marked under hyperventilation. A CT scan was taken. A low density cyst was observed; it was approximately 6×8 mm in size, localized at the left external capsule which remained unmodified through contrast injection and did not produce a mass effect. The ELISA test was positive for cysticercosis; neurocysticercosis was diagnosed.

The patient was hospitalized for treatment. The incoming neurological examination was normal. A few days later, an event which is important to the understanding of his later delusion occurred. The patient, bothered by another patient's complaints, asked the nurse to give his neighbor a tranquilizer, and argued with the nurse. The next morning, treatment with Praziquantel was begun. Two days later, while the patient's mother was visiting him, he told her that the patient in the next bed had died because of an overdose of tranquilizers administered at his request. He also said that the person who was in that bed was double of the one who had died; that it was not the actual patient. A delusion set in and the patient was handled throughout his stay at the hospital with Haloperidol and Akineton.

A neuropsychological evaluation was carried out. The patient was adequately oriented; his speech was slow, and a decrease in his articulatory ability and syllabic reiterations was observed. There were changes in his handwriting, which he performed with noticeable

slowness. His reading was slow; he demonstrated difficulty in understanding complex texts. His conversational understanding was adequate; he followed verbal orders without any difficulty. He pointed at the named objects, parts of the body and colors. There was slight right hemi-spatial neglect when copying drawings. He retained seven bi-syllabic common words after four repetitions and was able to recall them at the end of the examination.

During testing, the patient reported that the nurses were wearing masks to confuse him; he insisted that they were not the same people but were only pretending to be. Moreover, he claimed that at times a tall blonde nurse came in, and later a short, dark one. To him, they were one and the same person; he realized this because they had the same voice. Everyone was trying to discover who was responsible for the other patient's death. When another patient underwent a blood transfusion, he understood it to be a message telling him that he was going to die. Everyone had been trying to confuse him and that was why they changed faces. A hospital doorman was passing as a doctor and the doctors as visitors.

It should be emphasized that at no time were any signs of prosopagnosia present. The patient recognized photos of well-known personalities, matched faces, remembered and recognized people he had recently met, and was able to describe familiar faces. He left the hospital having completed his treatment. Upon returning home, he reported feeling it to be different; "the rugs seem thicker and brighter in color." When he went to the dentist, he found that the dentist was not the same person as the one who used to see him, but looked like him. He realized this because the original dentist had been more talkative.

He returned for follow-ups and mentioned how much things had changed; little was the same as before. He stated that he was seeing the world as a different place and himself as a different person since being at the hospital. He continued blaming himself for the other patient's death and reported the existence of a plot against him for the same reason. He also said that people had changed places or that the same person had taken on a different appearance. He mentioned that everything was absurd but true at the same time because he knew how frequent people got killed at hospitals.

Noteworthy, this patient spontaneously stated that the world had changed and his interpretation of the surrounding conditions was not the same. He stated that he was seeing the world as a different place and himself as a different person since being at the hospital. In other words, he was now living in an idiosyncratic world, different from the world existing before his brain condition.

It should be emphasize that these four patients present a constellation of symptoms that have been well described in the neuropsychology literature: prosopagnosia was initially described by Bodamer (1947); Gertsmann syndrome was described by Gerstmann (1940); dysexecutive syndrome is a well-known syndrome reported by many authors in contemporary neuropsychology (Baddeley & Wilson, 1988); and Capgras syndrome was reported by Capgras and Reboul-Lachaux (1923) (Ardila, 2016b); in such a regard, they are not unique cases, but rather typical cases. Differences in their interpretation of the surrounding conditions are quite evident and are obviously associated with the particular type of pathology they present. Indeed, the brain conditions in the four cases can be considered as typical. We can speculated that the cognitive world in different neuropsychological syndromes – aphasia, amnesia, and so forth—quite likely present significant similarities; for instance, two patients with a Broca's aphasia have a significant communality of deficits, and hence their perception and interpretation of the world has to be similar in a significant extent. But the cognitive world has to be rather different among different neuropsychological syndromes; so, the cognitive world of the patient with aphasia has to be different of the cognitive world of the patient with agnosia.

Dispersion of cognitive abilities in normal people

Individual different in cognition and behavior are significant (Gale & Edwards, 2016). Few studies, however, have specifically approached the question of normal individual differences in neuropsychological test performance using a comprehensive test battery. Ardila, Galeano, and Rosselli (1998) analyzed the dispersions in scores for relatively usual neuropsychological tests in a group of normal subjects. A population sample of 300 normal homogeneous (according to the selection variables) subjects from a middle socioeconomic class was studied. Participants were right-handed male university students between 17 and 25 years of age ($M = 21.04$; $SD = 2.41$). All subjects were Colombians, living in Medellin, Colombia (population around 2,000,000 inhabitants) and were native Spanish speakers. An attempt was made to collect comprehensive information covering seven different neuropsychological domains: language, memory, calculation skills, spatial abilities, perceptual skills, praxic abilities, and executive functions. Most of the tests that were selected are well-known tests with established reliability and validity. In some cases, however, it was necessary to develop new tests adapted to the goals of this research. General test results are presented in Table 1.

Table 1. Means and standard deviations found in different neuropsychological tests in a 300 normal male participants.

Test	Mean score	*SD*	CV%	Range
1. Auditory recognition				
1.1. Recognition of popular songs	17.0	4.1	24	0–21
1.2. Seashore Rhythm Test	25.7	3.3	13	9–30
2. Verbal Fluency				
2.1. Phonologic verbal fluency	34.8	7.6	22	9–52
2.2. Semantic verbal fluency	44.2	7.5	17	22–74
3. Nonverbal Fluency	12.0	7.2	60	0–40
4. Serial Verbal Learning				
4.1. First trial	5.7	1.6	28	1–10
4.2. Number of trials	4.4	1.8	41	1–10
5. Finger Tapping Test				
5.1. Right hand	61.2	10.4	17	23–88
5.2. Left hand	53.0	8.7	16	21–79
6. The Rey-Osterrieth Complex Figure				
6.1. Copy	34.9	1.7	5	26–36
6.2. Immediate memory	28.2	5.0	18	9–36
7. Ratcliff s test	26.6	5.1	19	3–32
8. Arithmetical abilities				
8.1. Mental arithmetic	5.3	1.9	36	0–8
8.2. Arithmetical problems	9.5	3.2	34	1–16
9. Localization of 10 cities on a map	20.1	8.2	41	0–42
10. Orthography test	21.3	4.0	19	10–30
11. Perceptual speed				
11.1. Similarities between two figures	4.9	2.0	41	0–10
11.2. Differences between two figures	6.8	2.0	29	3–20
11.3. Hidden figures	8.5	2.1	25	2–10
12. Reading speed	172.3	46.7	27	64–426
13. WAIS				
13.1. Information	16.7	4.4	26	4–27
13.2. Similarities	18.7	3.6	19	6–26
13.3. Arithmetic	11.8	7.7	65	3–18
13.4. Vocabulary	53.5	9.2	17	18–76
13.5. Comprehension	17.6	4.5	26	6–27
13.6. Digits	11.6	2.2	19	5–17
13.7. Picture completion	16.8	2.8	26	8–21
13.8. Picture arrangement	25.3	5.5	22	10–36
13.9. Block design	39.3	7.4	19	0–48
13.10. Object assembly	31.7	7.6	24	2–44
13.11. Digit-symbol	56.0	15.0	28	11–90
14. Wechsler Memory Scale				
14.1. Information	5.8	0.4	6	3–6
14.2. Orientation	4.9	0.2	4	4–5
14.3. Mental Control	7.3	1.9	26	0–9
14.4. Logical Memory	15.1	3.2	21	5–21
14.5. Visual Reproduction	12.1	1.9	16	0–19
14.6. Associative Learning	18.1	3.1	17	3–26
15. Wisconsin Card Sorting Test				
15.1. Categories achieved	5.7	1.1	19	0–6

Note: Adapted from Ardila et al., 1998. CV% (% coefficient of variation) = the standard deviation divided by the mean, expressed as a percentage.

It is observed that mean scores were, in general, those expected according to the subjects' age and educational level (Ardila, Rosselli, & Puente, 1994; Lezak, Howieson, & Loring, 2004; Strauss, Sherman, & Spreen, 2006). For some of the tests, there are no available norms for comparisons. However, for the purpose of understanding individual differences, the most important information refers to the standard deviations in combination to the score ranges. For all the tests, the score ranges in this normal group of university students are particularly large; for instance, for sake of illustration three scores can be mentioned—one verbal, one nonverbal, and one executive function score—WAIS Vocabulary raw score range was 18–76 (mean score = 53.5; *SD* = 9.2); WAIS Block design score range was 0–48 (mean score = 39.3; *SD* = 7.4); and Categories in the Wisconsin Card Sorting Test was 0–6 (mean score = 5.7; *SD* = 1.1). For all the rest of the tests, similar results were observed. The SDs are also large across measures and in most cases corresponding to more than 30% of the mean value as indicated by the coefficient of variation (CV = the standard deviation divided by the mean × 100) presented in percentages in Table 1. The SD is an indication of the spread of observations and this coefficient is indicating the heterogeneity of the participants' cognitive abilities. Simply speaking, dispersion of scores in diverse neuropsychological tests in a relatively homogenous population (at least age, gender, SES, education level, and cultural background variables are controlled) is enormous.

Comment

Departing from the aforementioned observations, it can be concluded that the dispersion of cognitive profiles is enormous in normal population individuals. That means, patterns of cognitive abilities are significantly heterogeneous even when major demographic variables are controlled. This dispersion in cognition can become more evident in cases of brain pathology.

It could be assumed that individuals live in idiosyncratic cognitive worlds, due to the differences in their patterns of cognitive abilities. The concept of cognitive world in neuropsychology can parallel the concept of "perceptual world" introduced by Uexküll (1957) in biology, which assumes that different animal species live in idiosyncratic perceptual worlds, given the differences in their sensory systems. Uexküll (1957) referred to the *Umwelt* as the perceptual world in which an organism exists. He was studying the sensory system of different animals, including the amoebae, jellyfish and sea worms' work; he speculated that those organisms have different experiences of the world and live in different perceptual worlds. As a result, the *Umwelt* is limited by the sensory capacities of each organism. By the same token, individuals live in different cognitive worlds resulting from the distinction between their patterns of cognitive abilities. No question, the cognitive world differs between a musician, a taxi driver, a lawyer, and a mathematician. The underlying assumed differences in cognition and daily activities, their experience of the world, and their worldview (*Weltanschauung)* has to be different.

Some attempts have been made to analyze how differences in neuropsychological abilities affect the world of the patient after brain damage. For example, Van Patten, Keith, Bertolin, and Wright (2015) argue for

the utility of a brief assessment of premorbid ADHD in the acute care of individuals with mild traumatic brain injury; Jefferies, Rogers, and Ralph (2011) demonstrated that individual differences in pre-morbid ability can give rise to category-specific semantic impairment in the context of global semantic degeneration.

This concept of cognitive world can potentially advance our understanding of humankind psychology, and individual differences in neuropsychological activity.

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