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CONTRIBUTION TO THE VALIDATION OF THE BRIEF-A FOR THE PORTUGUESE POPULATION

VALIDITY STUDIES WITH OLDER ADULTS

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ABSTRACT

Introduction: In the last decades, the number of older people has been growing throughout the World. This demographic tendency has practical implications and requires the comprehension of the particularities of this age group. Neuropsychological assessment plays an important part, allowing a better understanding of normative and pathological aging and involving several domains of functioning, namely cognitive. Executive functions are frequently addressed because they are central to the comprehension of the aging process, demanding the existence of validated tests.

Objective: This study aims to contribute to the validation of the BRIEF-A (*The Behavior Rating Inventory of Executive Function – Adult Version;* an inventory of executive functioning) for the Portuguese population by analyzing relationships between BRIEF-A and several instruments within cognitive, functionality, socio-affective and personality domains (convergent/divergent validity).

Method: A convenience final sample of 25 subjects aged 60 or over (M= 69.60; DP= 8.231) and their informants was used. The protocol included 9 instruments: Brief semi-structured interview; BRIEF-A; ACE-R; Phonemic Fluency Test; IAFAI; REY-15 Item; NEO FFI; STAI-Y and GDS-30.

Results: Significant moderate correlations were found between some BRIEF-A parameters and ACE-R domains (varying between .418 and .641). Between BRIEF-A parameters and Verbal Fluency Tests low to moderate correlations were found (between .398 and .557); Working Memory scale showed a significant moderate correlation with Advanced Instrumental Activities of Daily Living (.427) and with cognitive incapacity (.419); significant moderate and high correlations were found between some BRIEF-A parameters and NEO FFI traits (between .411 and .719); significant moderate correlations were shown between some BRIEF-A scales, STAI-Y Trait (between .451 and .615) and GDS-30 (between .413 and .576). Additionally, differences between two age groups were found in the distribution of some BRIEF-A parameters.

Conclusion: Even if this study suffers several limitations (reduced sample size, limited geographical area and protocol used), the instrument demonstrated correlations with cognitive domains, two personalistic traits (Conscientiousness and Neuroticism) and a similar pattern to the one found by the original authors with STAI-Y and GDS-30. These initial findings were interesting and investigations aiming to validate the instrument should continue.

Keywords: BRIEF-A; executive functions; aging; convergent validity; divergent validity

RESUMO

Introdução: Nas últimas décadas, o número de pessoas mais velhas tem crescido por todo o Mundo. Esta tendência demográfica acarreta implicações práticas e requer a compreensão das particularidades deste grupo etário. A avaliação neuropsicológica detém um papel importante, permitindo uma melhor compreensão do envelhecimento normativo e patológico, incluindo vários domínios de funcionamento, nomeadamente o cognitivo. Neste âmbito, as funções executivas são frequentemente abordadas por serem centrais no processo de envelhecimento, exigindo a utilização de instrumentos de avaliação devidamente validados.

Objetivo: Este estudo visa contribuir para a validação do BRIEF-A (*The Behavior Rating Inventory of Executive Function – Adult Version;* um inventário de funções executivas) para a população portuguesa, analisando as relações entre o BRIEF-A e vários instrumentos dos domínios cognitivo, funcional, socio-afetivo e de personalidade (validade convergente/divergente).

Metodologia: Foi utilizada uma amostra de conveniência constituída por 25 sujeitos com 60 anos ou mais (M= 69.60; DP= 8.231) e seus informantes. O protocolo incluiu 9 instrumentos: Entrevista semi-estruturada; BRIEF-A; ACE-R; Teste de Fluência Verbal Fonémica; IAFAI; REY-15 Item; NEO FFI; STAI-Y e GDS-30.

Resultados: Correlações significativas moderadas foram encontradas entre parâmetros do BRIEF-A e domínios do ACE-R (variando entre .418 e .641). Entre parâmetros do BRIEF-A e Testes de Fluência Verbal foram encontradas correlações baixas a moderadas (entre .398 e .557); a escala MT demonstrou uma correlação significativa moderada com AIVD-A (.427) e com incapacidade cognitiva (.419); correlações significativas moderadas a altas foram encontradas entre alguns parâmetros do BRIEF-A e o traço personalístico Conscienciosidade (entre -.414 e -.719) do NEO FFI e um padrão inverso foi encontrado para o traço Neuroticismo (entre .411 e .569); correlações significativas moderadas foram encontradas entre alguns parâmetros do BRIEF-A, STAI-Y Traço (entre .451 e .615) e GDS-30 (entre .413 e .576). Adicionalmente, diferenças entre dois grupos etários foram encontradas na distribuição de alguns parâmetros do BRIEF-A.

Conclusão: Ainda que este estudo tenha algumas limitações (reduzido tamanho da amostra, limitada área geográfica e protocolo utilizado), o instrumento mostrou correlações com domínios cognitivos, com dois traços personalísticos (Conscienciosidade e Neuroticismo) e um padrão semelhante ao demonstrado pelos autores originais com o STAI-Y Trait e a GDS-30. Os resultados iniciais foram interessantes e as investigações no âmbito da validação do instrumento devem continuar.

Palavras chave: BRIEF-A; funções executivas; envelhecimento; validade convergente; validade divergente

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Aos meus pais pelo apoio incondicional.

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I. INTRODUCTION

The number of older people has been growing worldwide at an increasing pace. This demographical tendency has been very challenging for countries as it demands several adaptations, for example socially (adapting to the needs of older people and having more people specializing in working with the elderly) and economically (having more expenses with pensions and health care) (Spar & La Rue, 2005; United Nations [UN], 2015). This tendency also provides some opportunities not only to older people (*e.g.* allowing them to pursue further education or activities of interest) but also to their families and to societies themselves (by sharing knowledge, for example) (World Health Organization [WHO], 2018).

As we age, our body ages too. There are changes in hearing, vision, in the bones, muscles, vascular system and even in our brain (Papalia et al., 2009; Park & Reuter-Lorenz, 2009; Spar & La Rue, 2005; WHO, 2015, 2018). There are also cognitive and psychological changes in normative aging, mainly in memory, processing speed, visuospatial ability, reasoning, attention and executive functions **(**Institute of Medicine [IOM], 2015; Park & Reuter-Lorenz, 2009; Pires et al., 2016; Spar & La Rue, 2005; WHO, 2015).

Executive functions, particularly, are a set of distinct but related elements, composed by abilities such as inhibition, working memory, cognitive flexibility, planning, abstraction, and decision making (Diamond, 2013; Pires et al., 2016). These functions are involved in complex behaviors such as remembering to take a pill, managing finances, and planning weekly activities (Pires et al., 2016). They have been associated with pre-frontal and parietal regions of the brain (Pires et al., 2016).

Executive functions are affected by normal aging, and in some pathological conditions, such as Alzheimer’s and Parkinson’s disease (Guarino et al., 2019; Rosselli & Torres, 2019). These functions are a strong predictor of daily functioning in the elderly as they are crucial to some daily living activities, namely instrumental ones (Bell-McGinty et al., 2002; Cahn-Weiner et al., 2010; McAlister & Schmitter-Edgecombe, 2016). They also seem to be associated with depressive symptoms, anxiety and even personalistic traits (Kang et al., 2014; Roth et al., 2005; Williams et al., 2010).

Neuropsychological assessment plays an important part in the comprehension of executive functioning in aging, and also in the detection of impairment. However, executive functions' evaluation is demanding as they are composed by different components and involve several regions of the brain (Faria et al., 2015). Some of the most used performance-based tests are the Trail Making Test, Verbal Fluency Tests, Wisconsin Card Sorting Test, among others. Additionally, some neuropsychological assessment batteries - which include several tests - are also used, such as BADS – Behavioral Assessment of the Dysexecutive Syndrome (see Pires et al., 2016). Self-report measures are also extremely important to include in the neuropsychological assessment of executive functions as they reflect daily struggles and the perception of the own individual (or their significant informant) (Roth et al., 2005).

In order to complement information not captured by other tests, Roth et al. (2005) proposed a self-report measure of executive functioning – BRIEF (Behavior Rating Inventory of Executive Function), where an informant form was also included. A version for specific usage of adult population (18 to 90 years old) was created (BRIEF-A; Roth et al., 2005).

The inventory was standardized and validated for general population (Roth et al., 2005), but has also been validated for specific clinical populations such as multiple sclerosis, Parkinson's disease, eating disorders and adults with Williams Syndrome (Ciszewski et al., 2014; Hocking et al., 2015; Kim et al., 2013; Lanni et al., 2014). A Portuguese version of the inventory is currently being tested and has shown good psychometrical properties (Lima, 2019; Ribeiro, 2019).

The present study aims to contribute to the validation of the BRIEF-A for Portuguese population, centering on older adults (60+ years old). The main focus was on convergent and divergent validity. The objective was to analyze the relationship between BRIEF-A scales and several other instruments: Addenbrooke Cognitive Examination – Revised (ACE-R), Mini Mental State Examination (MMSE) and Verbal Fluency Tests (Cognitive dimension); Adults and Older Adults Functional Assessment Inventory (IAFAI) (Functionality dimension); NEO Five Factor Inventory (NEO FFI), State-Trait Anxiety Inventory (STAI-Y) and Geriatric Depression Scale – 30 Item (GDS-30) (Socio-affective and personality dimension).

However, this study was severely limited due to the contingencies imposed by the worldwide pandemic of COVID-19. The sample size was reduced and geographically restricted, as circulation restrictions were imposed. Initially, sample size was around 50 subjects (being reduced to a final sample of 25). As the protocol included tests that demanded physical contact, sample collection had to be interrupted for several months in order to protect participants.

Nevertheless, BRIEF-A validation studies should continue as the instrument has proved to be an useful neuropsychological assessment tool.

II. THEORETICAL FRAMEWORK

1. The aging process

For the first time ever, people can make plans for their older age (WHO, 2018; Spar & La Rue, 2005). In the last decades, the World has witnessed a demographic tendency: the number of older people (aged 60 years or over) is growing – and this tendency does not seem to cease. According to the World Health Organization, between 2015 and 2050 the proportion of people over 60 years old will almost double, from 12% to 22% (WHO, 2018). Hand in hand, the number of people older than 80 will also grow (UN, 2015). These demographic changes are due to several reasons but mainly because of the decrease in fertility and the increase in longevity (UN, 2015).

Portugal has not been an exception. In 1960, there were only approximately 46 older persons per 100 younger ones. Almost 60 years later, in 2018, there were approximately 158 older persons per 100 younger ones (PORDATA, 2019). In 2018, older people (+65 years-old) represented 21,8% of the total Portuguese population, whereas younger people (aged 0-14 years-old) represented only 13,7% (Instituto Nacional de Estatística [INE], 2019). In Portugal, a person born between 2016 and 2018 could expect to live more than 80 years (INE, 2019).

This demographic tendency of aging has, of course, practical implications. There has been a need to adapt economically, socially and politically to these changes in order to respond to the challenges that an aging population offers, such as expenses in health care and pensions, for example (UN, 2015). Professionals specialized in working with older age are needed, mainly when it comes to health care and mental health care (Spar & La Rue, 2005).

People age individually as years pass and signs of aging start to appear at a certain point. Biologically and psychologically it is difficult to define when a person reaches "older age", given the fact that changes occur gradually (Spar & La Rue, 2005) and that there is marked heterogeneity in this age group – even though we all age, we do not age the same way. However, people age in society as well. An example of this are the categories of age in which people are divided (young age, active age, and older age) and each one has its particularities and roles (Rosa, 2012). Sometimes the criterion used to define "older age" is retirement age, but this has been changing over the previous years and varies throughout the World - in Greece and Italy, retirement age is 67; in China and India, it is 60 years old (Trading Economics, 2019). In Portugal, retirement age is currently 66 years old (Portaria nº25/2018, 2018). It is clearly not a consensual criterion to use in order to define "older age". Given this, the starting age of "older age" might vary according to what we want to address and approach.

One of the difficulties in adapting to the necessities of this age group is its heterogeneity (mentioned above). Biologically, the reason why we age is given by many different theories, but it is commonly accepted that the aging process is a result of gradual cellular damage (WHO, 2015, 2018). Normative changes include decline in vision and hearing, changes on the skin and hair, bones, and muscles (Papalia et al., 2009; WHO, 2015, 2018;). Every system in our body changes with age: systolic tension rises due to changes in the cardiovascular system, the lungs lose some of its capacity, metabolism becomes slower and there is a loss of muscular strength (Spar & La Rue, 2005). In the aging brain there is a decline in dopaminergic receptors, some structures shrink, white matter becomes less dense and there might exist amyloid plaques and neurofibrillary tangles (Park & Reuter-Lorenz, 2009), associated with some forms of Alzheimer's disease.

Cognitively and psychologically, there are normative declines in **working and recent memory**, **speed of information processing**, **visuospatial ability**, **reasoning** (especially in problem resolution and when referring to unfamiliar situations), **motor perception skills**, **attention** (specially selective attention and divided attention) some aspects of **language** (such as language production skills) and **executive functions** (global cognitive flexibility, inhibition of irrelevant information, planning) (IOM, 2015; Park & Reuter-Lorenz, 2009; Pires et al., 2016; Spar & La Rue, 2005; WHO, 2015). Despite all of these changes, some aspects seem to be relatively stable: intelligence (specially crystallized abilities), long-term memory, implicit memory and working memory storage (relevant aspects about personal history seem to be preserved) (IOM, 2015; Park & Reuter-Lorenz, 2009; Pires et al., 2016; Spar & La Rue, 2005).

However, many factors influence these changes: education (higher levels of education are inversely correlated with cognitive impairment), health (adults with good health do better in neuropsychological assessment tests than adults with disease), lifestyle (for example physical and mental activity relate to better cognitive performance), socioeconomic status and even personality (individuals with higher levels of neuroticism are more susceptible of suffering from depression, which is associated with poorer cognitive performance) (IOM, 2015; McCrae & Costa, 1987; Spar & La Rue, 2005; WHO, 2015, 2018).

Thus, perspectives on aging and older age differ. A more negative view thinks of older age as a period of losses, deterioration (physical and cognitive), endings (working period, relationships and even death) and negative feelings, such as solitude (Rosa, 2012). An opposing view faces aging as a period of wisdom, opportunities, and recognition, even though health deterioration does occur (Rosa, 2012; WHO, 2018).

As we have approached, some cognitive losses are normative with aging, including within executive functions. These functions change with age and are essential to many daily life activities, so its evaluation is important in order to predict daily functionality and quality of life in older age. We are going to address several aspects of executive functioning throughout the next chapters.

2. Executive functions

It is hard to define what executive functions actually stand for. They are the reason why we are able to do some tasks that involve organizing and selecting information, decision making and adaptation to complex situations (Pires et al., 2016). They also take part when it comes to social and emotional regulation (Pires et al., 2016). Remembering when to take a pill, dialing a phone number or planning weekly activities are brief examples of tasks that involve executive functions (Pires et al., 2016).

However, there is some debate related to the nature of executive functions. Some investigators stand for an unitary perspective – one ability is responsible for every process in executive functioning - while others stand for a non-unitary nature – there are distinct but related processes that act together in executive functioning (Jurado & Rosselli, 2007).

Several models and theories about executive functions have been proposed throughout the years. In 1974, Baddeley and Hitch suggested a model of working memory where a phonological loop, a visuospatial sketchpad and a central executive (that controls and regulates cognitive processes) were included (see Jurado & Rosselli, 2007). In 1986, Norman and Shallice proposed a model that included a Supervisory Attentional System fundamental for planning future actions, making decisions and working with new information (see Jurado & Rosselli, 2007). In 1992, Stuss defended that there are three levels of monitoring, placed on the frontal lobes: the first level, responsible for daily activities, the second level, responsible for executive functions that organize information and consequently behavior, and the third level, responsible for processing self and environmental awareness (see Jurado & Rosselli, 2007). In 1997, Zelazo et al. defended that there is a complex function with executive subfunctions, working together to solve problems (see Jurado & Rosselli, 2007). Ardila (2008) suggests a model for aggregating several abilities which divides in two: (1) "Metacognitive executive functions" (that include problem solving, abstraction, planning, working memory), which are usually measured in neuropsychological instruments; and (2) "Emotional/motivational executive functions" (responsible for the coordination of cognition and emotion). The author affirms that these abilities rely on different brain areas.

Some models, therefore, defend the existence of a central executive, centered in the prefrontal area, whereas others decline the uniqueness of the frontal lobe in controlling executive functions (Jurado & Rosselli, 2007).

Nevertheless, we are going to refer to executive functioning as a set of distinct but related components and we are going to address them individually in the next chapter (2.1). Different models propose different components of executive functions (Pires et al., 2016; Roth et al., 2005;), but some common examples are inhibitory control (the process that allows us to choose the way we react and behave despite internal predispositions, impulses and/or external influences), working memory (the ability to hold information and work with it, needed to manage information no longer present) and cognitive flexibility (the capacity to change spatial or interpersonal perspectives, to change the way we think and to adapt to new demands or situations) (Diamond, 2013) (see chapter 2.1 in this thesis).

Different regions in the brain have been associated with executive functions, but mainly pre-frontal and parietal areas (Pires et al., 2016). The pre-frontal cortex also seems to have an important role, mainly in behavioral regulation, emotional regulation and decision making (Denburg & Hedgock, 2015, as cited in Pires et al., 2016). Patients with damage in this area of the brain show difficulties in judgment, decision-making, organization, and behavior inhibition (Elliot, 2003). Patients with Alzheimer disease and frontal dementia also struggle with tasks that involve executive functions, and the same is true for individuals suffering from depression and schizophrenia. This happens because in all these cases there is some damage in the frontal lobe or fronto-subcortical connectivity (Elliot, 2003).

The development of executive functions is not as premature as other cognitive functions because of their complexity (Roth et al., 2005). It is suggested that the development of executive functions resembles an inverted "U" shape over the lifespan, evolving during childhood and adolescence and declining with aging (Zelazo et al., 2004). In fact, some executive functions are still developing in adulthood, such as emotional and behavioral self-regulation. However, as mentioned, their decline is not abrupt in healthier, older individuals and is not normally found in every function (Roth et al., 2005).

Executive functions are on the basis of many daily life behaviors, such as remembering where we stored something, counting the amount of money needed for shopping, planning weekly activities, dialing a phone number, among many others (Pires et al., 2016). Deficits in executive functioning usually relate to changes in behavior, cognition, and daily life functioning (Amieva et al., 2003). These deficits have been associated with hyperactivity disorder (Fatima, 2019a), autism (Fatima, 2019b), traumatic brain-injury (Garcia-Barrera et al., 2019), substance abuse (Inozemtseva & Núñez, 2019) and aging (Rosselli & Torres, 2019). We are going to approach executive dysfunction in aging in the next chapter/section (2.1).

2.1 Executive functions and aging

As mentioned before, alterations in executive functions are normative with age. A common accepted and neuroimagiological supported theory – proposed by West (1996) – claims they happen due to the aging of the pre-frontal cortex, one of the first areas in the brain to change with age (see Pires et al., 2016). Given the fact that this frontal region is more vulnerable to the effects of age, older people are consequently more vulnerable to changes in its functions (mainly executive functions) (Jurado & Rosselli, 2007). This theory is supported by the fact that older adults tend to perform worse in neuropsychological and executive functions tests, compared to younger adults (Crawford et al., 2000). It is important to refer as well that in some neuropsychological tests that evaluate executive functions older people can have a similar performance to younger ones, such as the Tower of London Test (see Pires et al., 2016).

Concerning **cognitive flexibility** and **task switching**, older adults tend to perform worse in tasks that involve selecting and maintaining two mental plans (**global cognitive flexibility**) but seem to preserve the ability to alternate between two mental plans (**specific cognitive flexibility** – for example, alternating between semantic categories) (Pires et al., 2016; Wasylyshyn et al., 2011).

Divided attention is also affected by age. Older people perform worse in tasks that require maintaining and manipulating visuospatial information. Their performance is affected as well in tasks that involve maintaining and manipulating verbal information. However, the ability to divide attention between tasks of different sensorial nature seems to be relatively preserved (for example, alternating between a visual and an hearing task) (Pires et al., 2016). Referring to **selective attention** studies show a decline in older age, what might be due to the inhibitory deficit of irrelevant stimulus (Haring et al., 2013; Park & Reuter-Lorenz, 2009).

In respect to **working memory**, updating capacity is affected by age – this updating capacity involves memory content, relevance and suppression of information no longer needed (for example, last minute changes in previously made plans) (De Beni & Palladino, 2004). However, storage capacity seems to be maintained. Older people seem to perform worse in working memory tasks that include spatial information (such as remembering where a stimulus appeared on screen) in comparison to working memory tasks that include verbal information (for example, remembering digits) (Myerson et al., 1999; Pires et al., 2016). When referring to **prospective memory**, responsible for future actions, the effects of aging are not quite clear. Older adults tend to perform as well as younger ones in tasks involving time based prospective memory in naturalistic settings (for example, remembering an appointment), which might be justified by the existence of external aids. However, significant impairment has been noted in older people in laboratory tasks. This might suggest that even if there is a decline in prospective memory with aging, it might not affect significantly daily activities. Deficits in complex tasks of prospective memory might also be due to the decline in other related functions, such as attention and planning (Henry et al., 2004; McDaniel & Einstein, 2011).

Inhibition is strongly affected by age when it comes to motor inhibition and irrelevant information inhibition (which are both controlled processes) – a task that involves these processes is the Stroop Test. When it comes to semantic inhibition, sensorial inhibition, and resistance to inappropriate information (automatic processes) they seem preserved in older people (Pires et al., 2016). This inhibitory deficit affects other cognitive domains such as task switching and response suppression (Park & Reuter-Lorenz, 2009).

Addressing the ability to **plan** (the process of formulating a sequence of actions in order to achieve a goal) older adult seem less capable of planning than younger ones. Nevertheless, when referring to normal aging, the capacity to elaborate mental plans seems to be more affected than the capacity to actually execute them (Allain et al., 2005; Pires et al., 2016).

Focusing on **abstraction** ability, which refers to the capacity to generate rules or concepts from specific objects (Pires et al., 2016), Albert, Wolfe and Lafleche (1990) found a decline in performance of older people in tasks evolving verbal and nonverbal stimulus. A test that evaluates abstraction is, for example, the Similarities subtest of the Weschler Adult Intelligence Scale (Albert et al., 1990; Pires et al., 2016).

More investigation is needed, but **decision making** also seems to be affected with age. This refers to the ability to choose something among several alternatives (Peters et al., 2011; Pires et al., 2016). The process of decision making is affected not only by aspects of the situation but also by the individual's characteristics. It appears that older people tend to have more difficulties in deciding when it comes to an unfamiliar situation and decide more slowly than younger people. However, motivation and emotional content seem to strongly affect decision making in the elderly and also that experience might compensate for some declines (Peters et al., 2007).

Models of executive functions are not fully consensual. For example, Roth et al. (2005) propose a model of executive functions composed by **Inhibition, Shift, Emotional Control, Self-Monitor**, **Initiate**, **Working Memory, Plan/Organize, Task Monitor** and **Organization of Materials**, which we are going to address later. However, there is an agreement on most dimensions and on the association between executive functioning and prefrontal areas of the brain (Pires et al., 2016).

It is also suggested that decreased processing speed severely affects older adults' performance on neuropsychological tests (Pires et al., 2016) and that these groups tend to adopt different strategies when solving tasks. This is more easily shown by neuroimaging techniques than by behavioral measures (Phillips & Andrés, 2010). In fact, differences in brain activation are shown when comparing older and younger people solving cognitive functions' tasks. Neuroimage techniques show that older adults seem to require more activity of the frontal lobe, even an overactivation in the prefrontal cortex (Park & Reuter-Lorenz, 2009). Some authors suggest that this is due to a compensatory mechanism developed in the brain in order to suppress deficits – *scaffolding* (Park & Reuter-Lorenz, 2009; Phillips & Andrés, 2010). This mechanism consists in the activation or overactivation of areas in the brain that aim to compensate for damaged structures and is a response to challenge (Park & Reuter-Lorenz, 2009). However, compensation is limited by task demands, cognitive reserve and emotional regulation (Phillips & Andrés, 2010).

As a matter of fact, some of the differences between individuals in cognitive aging might be justified by cognitive reserve (not only in performance variations but also in susceptibility to some diseases). It also justifies a slower rate in the decline of cognitive functioning in normal aging and acts as a protective factor against dementia and cognitive impairment. This reserve is created by educational and occupational experiences – even in later life. Other lifestyle factors, such as physical exercise and social interactions, also seem to contribute positively for cognitive reserve (Fouber-Samier et al., 2012; IOM, 2015; Stern, 2009, 2012). Nevertheless, when pathology does exist, it reaches a point that its severity can no longer be compensated by cognitive reserve, and decline may be more abrupt in these cases (see Stern, 2012).

Executive dysfunction may be a result of normal (as approached previously throughout this chapter) or pathological aging. In Parkinson's disease executive dysfunctions are identified even in early stages of the disease and are characterized by impairment in working memory, planning, attentional control and set-shifting (Rosselli & Torres, 2019). Vascular disorders may also result in executive dysfunction - after a stroke, for example (Rosselli & Torres, 2019) - and patients with ischemic vascular disease also demonstrate difficulties in initiating activities, inhibitory control of irrelevant answers and maintaining adequate behavior for a certain task (Lamar et al., 2010, as cited in Rosselli & Torres, 2019). In Alzheimer's disease there exist impairments in planning, inhibition, flexibility, and divided attention (Godefroy et al., 2017, as cited in Rosselli & Torres, 2019; Guarino et al., 2019).

These impairments in executive functioning significantly affect daily functionality, as we are going to approach in the next section (2.2).

2.2 Executive functions, aging, and functionality

Executive functions play a fundamental role in our every day's life, as mentioned previously. They control processes such as planning and problem-solving (Amieva et al., 2003) and they are necessary to execute daily living activities, such as management of one's home, medication, and finances. In fact, it seems that they are a strong predictor of everyday functioning in older adults (Bell-McGinty et al., 2002; Cahn-Weiner et al., 2010; McAlister & Schmitter-Edgecombe, 2016). Functional capacity may be defined as a variety of skills and abilities that allow someone to live independently in the community (Loewenstein & Mogosky, 1999, as cited in Marson & Hebert, 2006). Impairment in daily functionality results in the need for assistance, poorer health and diminished life quality (Angel & Frisco, 2001, as cited in Marson & Hebert, 2006).

These abilities are usually divided in Basic Activities of Daily Living (BADLs) and Instrumental Activities of Daily Living (IADLs). The first ones (BADLs) include basic activities that are based on procedural memory skills and basic motor functioning and that are relatively automatic. Examples of these activities are bathing, eating, using the toilet and walking inside the house. The ability to perform these activities tends to remain preserved in normal aging and throughout the first stages of demential processes (Marson & Hebert, 2006; Sousa et al., 2008). IADLs are more complex and exigent tasks that demand controlled processing, executive functions, and procedural memory (Patterson et al., 1992, as cited in Marson & Hebert, 2006). These include managing finances, managing medications and using transportation (Marson & Hebert, 2006; Sousa et al., 2008). These skills are evidently impaired in the first stages of dementia and mild cognitive impairment (Marson & Hebert, 2006). IADLs are divided into Household Activities of Daily Living and Advanced Independent Activities of Daily Living. The first include activities required to manage and maintain a home, such as shopping, preparing meals and doing laundry. The second demand higher levels of cognitive functioning and include activities like driving, using public transportation, managing finances and medications (Marson & Hebert, 2006; Sousa et al., 2008).

Neuropsychology plays a fundamental role in the early identification of impairments in daily living, evaluating the functional status of older individuals through executive functions. This identification is needed in order to assure proper care to the individual, an early intervention and reduction of care-giving burden (Bell-McGinty et al., 2002; Cahn-Weiner et al., 2010). Assessment of daily functionality is usually made through self and informant reports and/or performance-based assessments (Marson & Hebert, 2006).

Even in pathological aging, executive functions are central to understand/to evaluate functionality. In Parkinson's disease, where there is motor and cognitive impairment, executive functions seem to predict instrumental activities of daily life (Cahn et al., 1998). In Alzheimer's disease, studies show that executive functions are impaired even in early stages of the dementia, what consequently leads to impairments in daily functioning as well (Guarino et al., 2019). In elderly depression, severity of the disease seems to be associated with impairments in executive functioning (Monteiro et al., 2016). Even when there is a remission of depressive symptoms, subjects seem to show more difficulties in executive functions' tasks and the premorbid level of cognitive functioning is usually not achieved (Houston & Bondi, 2006; Monteiro et al., 2016; Osorio et al., 2009). In the next section (2.3) we will review the association between depressive symptoms, anxiety and personality and executive functioning.

So, with the implications of aging in executive functions addressed previously, it is comprehensible how it might affect daily functioning, independence, and self-care and how it is important to understand and evaluate executive functioning in the elderly.

2.3 Executive functions, aging, socio-affective aspects and personality

Even when it comes to emotional regulation, executive functions play an important part. According to Rueda and Paz-Alonso (2013), executive functions are responsible for the comprehension and differentiation of more complex emotions and for self-regulation, which allows the adaptation to social environments and the accomplishment of goals (Rueda & Paz-Alonso, 2013). It is suggested that increases in emotional understanding and regulation are associated to the maturation of executive functions (such as inhibition and attention) (Rueda & Paz-Alonso, 2013).

It seems that difficulties in inhibiting negative stimuli and diminished cognitive flexibility are associated with psychological problems, such as depressive episodes (Lantrip & Huang, 2017), so an early detection of these struggles would allow a more effective intervention.

As mentioned before, depressive symptoms seem to be associated with difficulties in executive functioning. Kang et al. (2014) suggest that functional impairments in depressed patients are due to deficits in executive functioning. Task switching, inhibition, working memory, planning, and processing speed impairments are commonly reported in depressive disorders (Kang et al., 2014; Rosselli et al., 2019).

In fact, in older age there is a syndrome named “depression-executive dysfunction syndrome” that is characterized by diminished interests in activities, psychomotor slowing and disability, and also reduced fluency, impairment in visual naming and paranoia (Alexopoulos et al., 2002) This syndrome includes as well depressed mood and insomnia. The authors conclude that executive dysfunction does occur in depression in older age, that it influences the course of depression and that it is actually an intrinsic part of some geriatric depressive syndromes (Alexopoulos et al., 2002).

Moreover, Beaudreau and O'Hara (2009) found that anxiety symptoms in older adults were associated with poorer inhibition, processing speed and attentional shift. Roth et al. (2005) affirm that acute and chronic anxiety might be associated with poorer performance in tests of executive functions throughout different populations. Yochim et al. (2013) found that anxiety symptoms in older adults from the community were related to poor performance in several tests of executive functioning involving categorization and task-switching.

In addition to this, Williams et al. (2010) suggest that personality characteristics might reflect individual differences in executive functioning. In fact, it seems that there is an association between the Five-Factor Model personality traits (McCrae & Costa, 1987) and executive functioning (Williams et al., 2010). Personality traits appear to change across the life-span: Extraversion and Openness have a negative correlation with age (they diminish as we grow older), Agreeableness and Conscientiousness are positively associated with age (even though some literature suggests a curvilinear association between Conscientiousness and age, showing a decline in the elderly) (Donnellan & Lucas, 2008) and Neuroticism is apparently negatively correlated with age, but this dimension may show increasing values in older adulthood (around 80 years old) (see Donnellan & Lucas, 2008).

Neuroticism trait, which makes people more predisposed to experience negative affect and feelings such as fear, anxiety, guilt and sadness (Denburg et al., 2009), has been related to poor response selection in certain tasks, poor decision making and task disengagement (Luu et al., 2000). It is a trait associated with the development of cognitive impairment, for example Alzheimer disease (Williams et al., 2010; Wilson et al., 2007).

The **Extraversion** trait can be defined by socialness, optimism, and assertiveness (Denburg et al., 2009). Its' influence on executive functions is not clear, however, it appears that extraversion is positively associated with performance on updating and inhibition tasks. When difficulty is greater, performance differences between groups are also shown, what might be due to a rise in the level dopamine available (Campbell et al., 2011).

A person who has a marked **Openness** trait is usually creative, original and prone to experiment (Denburg et al., 2009). It seems that there exists a positive correlation between this trait, cognitive ability, and executive functions' tasks (DeYoung et al., 2005; Williams et al., 2010).

Someone with a marked **Agreeableness** trait tends to be prosocial, altruistic, and trustful (Denburg et al., 2009). This trait is apparently related to executive functions through the inhibition of inappropriate interpersonal behavior (Williams et al., 2010). The ability to inhibit inappropriate interpersonal behaviors seems to diminish with age (von Hippel, 2007).

Conscientiousness trait is characterized by the will to follow rules and norms, to plan and prioritize tasks (Denburg et al., 2009). It is related to organization, persistence, self-discipline, and impulse control (Williams et al., 2010). Findings are not consistent, but some studies suggest that it is negatively correlated to impulsivity (Williams et al., 2010). Conscientiousness seems to have a protective effect against the development of Alzheimer disease, mild cognitive impairment, and rapid cognitive decline. This trait also seems to be positively associated with resilience and to be a strong indicator of involvement in social and occupational activities (Wilson et al., 2007).

Personality traits seem to have an impact on executive functioning and on cognitive ability throughout the lifespan, and, consequently, on functionality. Personality evaluation, therefore, might work as a predictor of cognitive decline risk (see Bell et al., 2019). An early identification of people prone to develop some impairment allows a faster intervention.

2.4 Evaluating executive functions

Evaluation of executive functions is difficult as it involves different brain areas and different components. Neuropsychological tests do not access every domain in executive functioning, as this process would take too long and result in sample difficulties, but the restriction in evaluation also results in a loss of information (Faria et al., 2015). Most studies combine the evaluation of more than one domain and the most studied ones are mental flexibility, verbal fluency, planning, working memory, inhibitory control and processing speed (Faria et al., 2015). Tests commonly used, and many with Portuguese studies, are: **Trail Making Test** (Cavaco et al., 2013a)– evaluates mental flexibility and the ability to alternate; **Verbal Fluency Tests – Semantic fluency** (Cavaco et al., 2013b) (with the category "**Animals**" for Portuguese population) and **Phonemic fluency** (with letters **P, M** and **R**, for Portuguese population) – evaluate processing speed, language production and the capacity to categorize; **Clock Drawing Test** (Santana et al., 2015) – evaluates planning; **Digits Forward and Backward subtests (*eg*. Wechsler Adult Intelligence Scale - Third Edition)** (Weschler, 2008) – evaluates working memory and temporary storage of information; **Stroop Test** (Espírito-Santo et al., 2015); – evaluates inhibitory control (the ability of suppressing unnecessary information) and selective attention; **Wisconsin Card Sorting Test** (Grant & Berg, 1948) - evaluates mental flexibility, inhibition and planning; **Tower of London Test** (Shallice, 1982) – evaluates planning ability (see Capovilla, 2006; Faria et al., 2015; Pires et al., 2016).

Performance in all these tests is affected by age, education, and even socioeconomic status (Faria et al., 2015).

In addition to these tests, there are neuropsychological assessment batteries (such as **BADS** – **Behavioral Assessment of the Dysexecutive Syndrome**) (Barbosa et al., 2011) that include several tests and enable a more comprehensive approach, evaluating not only executive functions but also daily functionality, behavior, personality and emotions. This is important because, as addressed previously, executive dysfunction might originate problems in these areas (Pires et al., 2016).

Choosing which test to use is difficult. It involves planning and organization: what is the main purpose of the investigation/evaluation, what functions are meant to be evaluated, what is the target population, how frequently has the test been used in previous studies and how adequate are its psychometric properties (Pires et al., 2016).

However, evaluation using only tests is itself problematic. When addressing executive functions' evaluation, accuracy and validity of the tasks is compromised given the fact that a poor performance might be justified by different reasons, for example brain injuries or psychopathology (Chan et al., 2008). Tests are also limited because of test-retest reliability and the discrepancy found between experimental tasks and naturalistic tasks (Chan et al., 2008). In addition to this, the ecological validity of the tests is also a challenge, as sometimes results on the tasks proposed might not reflect severe difficulties in daily functioning (Chan et al., 2008; Roth et al., 2005). It is also possible that executive functions' tests do not detect deficits, and that theses deficits do happen in the daily activities of people with brain injuries (Barkley, 2012). There is, therefore, a need to capture the dynamics of the individual's daily life in order to comprehend difficulties faced and adjust recommendations given based only on neuropsychological assessments (Roth et al., 2005). The study of executive functions in aging from a behavioral perspective is extremely important (Amieva et al., 2003). In fact, decline or impairment in executive functions usually results in diminished daily functionality and in the inability to perform certain complex behaviors as well (Bell-McGinty et al., 2002; McAlister & Schmitter-Edgecombe, 2016). As mentioned before, and to summarize, executive functions are important predictors of daily functionality in the elderly, so its early evaluation is crucial (Cahn-Weiner et al., 2010).

Self-report measures, in which it is possible for the person to express daily struggles on specific tasks, contribute for the evaluation and comprehension of the problem. Some self-report measures are commonly included in clinical evaluation protocols, but they usually assess emotional, behavioral and personality aspects of the individual (for example Beck Depression Inventory, State-Trace Anxiety Inventory and Personality Assessment Inventory) (see Roth et al., 2005). The DEX (Dysexecutive Questionnaire) addresses common symptoms of the dysexecutive syndrome and is commercialized together with BADS, previously referred (Wilson et al., 1996). However, subjective reports on daily life difficulties (involving executive functions) can complement decontextualized information captured by other instruments (Bell et al., 2019).

Therefore, aiming to understand the person's perception of their own strengths and needs, Roth et al., (2005) developed an inventory for adults that includes a self-report and an informant's report measure – the BRIEF-A (Behavior Rating Inventory of Executive Function- Adult Version). The self-report measure allows the investigator to assess the person's perception of their functional difficulties and the answers give important information when compared to the informant's ones, for example on the level of awareness the person has of the difficulties (agreement or denial) (Roth et al., 2005).

The informant report is crucial when the individual has cognitive impairments or has poor awareness of the dysfunction (Roth et al., 2005). Someone who is regularly in contact with the person may provide valuable information on their difficulties and contribute for the comprehension of the problem and consequent intervention (Roth et al., 2005).

The authors, however, point out that self-report measures alone are not a valid diagnostic tool and require convergent information from informants, clinicians, neuropsychological performance tests and direct observation in natural setting, when possible (Roth et al., 2005).

It is usually suggested that an integrated model is used in neuropsychological assessment with older people. An interview is an indispensable part of the assessment, allowing the gathering of important information (see Simões et al., 2016). Interviews can be individual, with the person being evaluated, or with informants. Sociodemographic information is collected, a brief mental state exam is made, behavior is observed, historical and clinical information is gathered. Brief cognitive assessment tests and neuropsychological batteries (which include specific tests, used alone or combined) can be used. Tests that address daily functioning, behavior, socioemotional and personality aspects are also important because these aspects are intertwined with cognitive impairment and results complement each other, contributing for the apprehension of the person as a whole (Simões et al., 2016).

Aspects to keep in mind when evaluating older people are existing difficulties in vision, hearing, and motor functioning, as they might influence test results and require the adaptation of the test itself or the evaluating process. In addition to this, medication, fatigue, literacy, motivational and rapport aspects should be addressed as they influence neuropsychological assessment performance and can be confounding to validity and test interpretation (Potter & Attix, 2006; Simões et al., 2016).

3. BRIEF-A – Behavior Rating Inventory of Executive Function – Adult Version

The Behavior Rating Inventory of Executive Function was first developed for assessing executive function in school-aged children (answered by parents and teachers), being easy to administer and score but also providing clinical valuable information (Roth et al., 2005). The BRIEF-Preschool Version was developed afterwards, aiming to address executive functioning of younger children. Later, the BRIEF-SR (Adolescent self-report version) was developed in order to measure adolescent's perspectives on his/her own regulatory functioning (Roth et al., 2005). All of these forms demonstrated appropriate psychometric properties: internal consistency, stability over time, content validity, internal structure/construct validity, divergence and convergence with other measures and also ability to detect executive difficulties in specific populations. Adult Version was based on the previous BRIEF versions (Roth et al., 2005).

The BRIEF-Adult version aims to address self-regulatory functioning of adults through their own perspectives and their close one's perspectives as well (Roth et al., 2005). Important to refer that the informant should be someone who knows and is frequently in contact with the person, such as the spouse, family, caregiver, nurse, health worker or other (Roth et al., 2005). The inventory was standardized and validated for use with a population age range from 18 to 90 years old (Roth et al., 2005). For applying the test there is a request to read the Professional Manual and follow the administration and scoring procedures proposed by the authors (Roth et al., 2005).

Materials for applying the inventory include the BRIEF-A Self-Report Form, the Informant Report Form and a pen or a pencil. Both forms should be answered separately by the person (self and informant). They should rate some behaviors on the frequency of problems identified during the previous month (*e.g.* "I have angry outbursts") – answers vary between "It has never been a problem for me" (1), "It has sometimes been a problem for me" (2), "It has often been a problem for me" (3). It takes approximately 15 minutes to complete the inventory (Roth et al., 2005).

The inventory has a total of 75 items that integrate 9 clinical scales, which are: Inhibit (8 items), Shift (6 items), Emotional Control (10 items), Self-Monitor (6 items), Initiate (8 items), Working Memory (8 items), Plan/Organize (10 items), Task Monitor (6 items) and Organization of Materials (8 items). These clinical scales form two main Indexes:

The Behavioral Regulation Index (BRI) and the Metacognition Index (MI), which together form the Global Executive Composite (GEC). The inventory also has 3 validity scales: Negativity Scale, Infrequency Scale (composed by 5 other items) and Inconsistency Scale (Roth et al., 2005).

The clinical scales intend to evaluate to which extent problems within a certain domain of executive functioning are perceived by the respondent (Roth et al., 2005).

The **Inhibit** scale reports to the ability to stop one's own behavior, to resist and not act impulsively. The **Shift** scale measures flexibility and ability to alternate focus, not only cognitively but also behaviorally. The **Emotional Control** scale evaluates the ability to give proper emotional responses. The **Self-Monitor** scale addresses the ability to supervise one's one behavior and estimate the effect it has on others. The **Initiate** scale measures the ability to begin a task and generate responses. The **Working Memory** scale refers to the capacity of keeping information in mind while completing a task. The **Plan/Organize** scale measures capacity to manage present and futures tasks, correctly establishing the steps for developing a task and order information to achieve an objective. The **Task Monitor** scale evaluates the awareness one has of his/her own failures and successes during problem-solving. Finally, the **Organization of Materials** scale refers to organization in one's own environment, in respect to work, living and storage spaces (Roth et al., 2005).

The **Behavioral Regulation Index (BRI)** is composed by 4 clinical scales: **Inhibit, Shift, Emotional Control** and **Self-Monitor.** It refers to the capacity of appropriate controlling one's behavior. The **Metacognition Index (MI)** is composed by 5 clinical scales: **Initiate, Working Memory, Plan/Organize, Task Monitor** and **Organization of Materials.** It represents the capacity of planning and organizing information for problem solving. Lastly, the **Global Executive Composite (GEC)** summarizes all the clinical scale and it represents the level of executive dysfunction, however, it should be interpreted carefully as it might despise important differences between the index scores (Roth et al., 2005).

As mentioned before, the inventory has 3 validity scales which should be considered before interpreting any other scores. The **Negativity** scale measures how negatively an individual answers to the inventory. A high score might suggest an overly negative view of the person or severe dysfunction, so results should be carefully reviewed and contextualized. The **Infrequency** scale measures atypical responses at some items. A high score might mean the person responded randomly or might have responded in an extreme manner. This might suggest an attempt to portray the person more negatively or positively than in reality, so other information such as behavioral observation and clinical judgment must be taken into account. The **Inconsistency** scale measures the way some similar items were responded differently by the same person. If there is a high score, the investigator needs to ascertain explanations with the respondent and if there are logical explanations, the protocol is valid (Roth et al., 2005). Other aspects of validity should be considered as well, such as inconsistencies with other information, respondent competency, omission of item responses and unusual patterns of responses (Roth et al., 2005).

3.1 Studies with BRIEF-A

The original BRIEF-A is validated for general population in the United States of America. Studies are also being developed within other countries (such as Spain, France, and Italy), adapting the instrument to its populations. For example, Mani et al. (2018) analyzed the validity and reliability of the inventory to the Persian population, finding good psychometrical properties.

However, studies using the instrument have also been developed with several clinical populations as well. Kim et al. (2013) evaluated construct validity of the BRIEF-A in individuals with multiple sclerosis; Lanni et al. (2014) used the inventory to analyze executive dysfunction in people suffering from Parkinson's disease; Ciszewski et al. (2014) tested validity and reliability of the instrument in people with eating disorders; Hocking et al. (2015) evaluated parents' report of daily impairment in adults with Williams Syndrome and concluded that the BRIEF-A is a valid measure of impairment.

In 2019, two investigations were developed in order contribute for the standardization and validation of the BRIEF-A for Portuguese population (Lima, 2019; Ribeiro, 2019). The first (Lima, 2019) study involved 130 adults and younger adults, and their informants, from several districts in Portugal. The second (Ribeiro, 2019) reported specifically to adults from 50 to 80+ years old (independent and cognitively healthy) and the sample included 218 individuals and their informants. The inventory was translated from English to Portuguese - both the self-report and the informant version - and a qualitative study was made addressing the comprehension of the items in the translated version. As item comprehension was guaranteed, this version was tested for validity and reliability.

Analysis of construct validity (exploratory factor analysis) considering do global sample of self-report (N= 239) and of informant (N=239) of both studies demonstrated a two-factor structure (Lima, 2019; Ribeiro, 2019) – the Behavioral Regulation Index and the Metacognition Index -, like what happened in original version (Roth et al., 2005). However, some other studies suggest a three-factor structure (see Donders & Strong, 2016; see Roth et al., 2013). This being said, confirmatory factor analysis studies are needed to clarify the instrument's construct validity. Lima (2019) found good values for internal consistency in both self-report and informant versions for BRI (self-report version α=.90, informant α=.90) and MI (self-report α=.93, informant α=.94). For the GEC, internal consistency was very good as well and similar for both versions (α=.95). All clinical scales presented acceptable to very good internal consistency values, except the Inhibit scale (α=.58 in both versions).

Ribeiro (2019), whose study focused mainly on older adults, found that internal consistency for the self-report form was very good for GEC (α= .94) and MI (α= .93) and good for BRI (α= .88). Clinical scales have acceptable to good internal consistency, except for the Inhibit scale in (Self-report version α= .49), similar to what happened in Lima's study (2019) – this suggests that this particular scale is not comprehensible or is not measuring the construct correctly. Internal consistency of the informant form was very good for Total (α= .97) and for both Indexes (MI α= .96; BRI α= .93) and acceptable to good in all clinical scales.

In Lima's study (2019), addressing intraclass correlations, results showed a good correlation for the Inhibit scale (r= .62), for Emotional Control (r= .71), Initiate (r= .65), Organization of Materials r= .74), and for BRI (r= .64), MI (r= .67) and GEC (r= .62). The other scales demonstrated fair values of correlation (Lima, 2019). Additionally, using a *t-student* test, great significant differences were found between versions in the Self-Monitor scale (p< .000), in the Inhibit scale (p= .001), Working Memory scale (p= .006), Task Monitor (p= .004) and BRI (p= .005). For the GEC, significant differences were also found (p= .037). For other scales, no significant results were found.

In Ribeiro's study (2019) interrater agreement presented acceptable values for all indicators, except for the Working Memory scale (which was excellent, *r*= .80). Additionally, significant differences were found for both indexes, for GEC and for every clinical scale, except for the Working Memory which did not show significant differences between the two versions (p= .082).

Results in the validity scales of BRIEF-A were also evaluated. For Negativity, 100% of the results were acceptable in the self-report form and 99,1% were acceptable in the informant form. For Infrequency, 97.2% and 99,1% were acceptable in the self-report and the informant form, respectively. Finally, for Inconsistency 99.1% of the results were acceptable both in self-report and informant form (Ribeiro, 2019).

When comparing gender, for the informant version significant differences were found in the Shift scale. For the self-report version, significant differences were found in the Shift, Emotional Control, Task Monitor scales, in the BRI and in the GEC. Results were higher for women than for men, which means that women tend to report more difficulties in executive functioning. In relation to age, significant correlations were found in the informant version for Emotional Control (*r*=.477), for MI (*r*=.721), for BRI (*r*=.550) and for GEC (*r*=.220). For the self-report version, significant correlations were found for Inhibit (*r*=-.184), Initiate (*r*=-.219), Plan/Organize (*r*=-.179), Organization of Materials (*r*=-.282) scales and for MI (*r*=-.225) and GEC (*r*=-.187) (Lima, 2019).

When it comes to divergent/convergent validity, which was exploratory in Ribeiro's study (2019), there is a significant positive moderate correlation between all BRIEF-A indicators and GDS-30 with the exception of the Organization of Materials scale (*r*= .22) (more depressive symptoms are associated with more executive functioning difficulties). There were also significant negative moderate correlations between some BRIEF-A indicators and MoCA, such as Working Memory (*r*= -.51), Plan/Organize (*r*= -.40), MI (*r*= -.50) and GEC (*r*= -.44) (more cognitive capacity is associated with less executive functioning difficulties) (Ribeiro, 2019).

Thus, concerning these studies, the BRIEF-A Self-report form and the Informant-report form evidenced adequate psychometric properties, making BRIEF-A a promising instrument for the evaluation of executive function for Portuguese adults and older adults.

There is, however, a need for testing BRIEF-A's concurrent validity for the Portuguese population: convergent ("the degree to which the new measure correlates, or converges, with other measures of similar traits" (Roth et al., 2005)) and discriminant validity[1] (the instrument's ability to differentiate normative from clinical groups and to "correlate less well rating scales of dissimilar characteristics" (Roth et al., 2005, p.66)).

Concerning the original study, analysis with the BRIEF-A and the Frontal Systems Behavior Scale (FrSBe) showed significant correlations between the two instruments (Roth et al., 2005). The same happened with the BRIEF-A and the Dysexecutive Questionnaire (DEX) and with the BRIEF-A and the Cognitive Failures Questionnaire (CFQ) (Roth et al., 2005).

Between the BRIEF-A and the Geriatric Depression Scale (GDS) there were moderate correlations for certain scales, such as Inhibit (.54), Emotional Control (.48) and Working Memory (.54) and modest correlations for others – Shift (.34), Self-Monitor (.32), Initiate (.38), Plan/Organize (.36), Task Monitor (.39) and Organization of Materials (.31). For the two indexes and for GEC correlations were moderate (BRI = .49; MI= .46; GEC= .50). Between the BRIEF-A and the State-Trait Anxiety Inventory (STAI) there was only one low correlation (Organization of Materials= .38) and moderate correlations with all the other domains of executive functioning and trait anxiety. Between executive functioning and state anxiety only low correlations were found (Roth et al., 2005).

So, the next stage is to investigate if a similar pattern of correlations is also found for the Portuguese population. The present study aims to contribute to validity studies with BRIEF-A for the Portuguese population, specifically with healthy older subjects from the community, concerning relations with GDS-30 Item and STAI-Y. Other studies are also being developed within clinical populations (*e.g.*, Mild Cognitive Impairment, Initial stage of Alzheimer Disease, substance use disorders).

Additionally, it seems interesting to investigate how BRIEF-A relates to daily functionality measures and to personality traits, as we have approached previously the degree in which these aspects influence each other. In fact, Formicola (2009) investigated the relationship between executive functioning and personalistic dimensions using

[1] The term *divergent validity* can be used to address discriminant validity as well. We decided to use the term *divergent* throughout this study because discrimination of clinical groups was not included as it was not the focus of this work.

BRIEF-A. The author found significant correlations between: (i) Neuroticism and emotional control, suggesting that those higher in Neuroticism would have more difficulties in controlling their emotions; (ii) Openness to Experience and better ability in shifting during problem solving; (iii) higher Neuroticism associated with more difficulties in shifting when solving problems; and (iv) higher Conscientiousness and higher Agreeableness related to better ability to inhibit behavior.

III. OBJECTIVES

This study is part of a wider investigation on the validation of the BRIEF-A for Portuguese population, aiming to contribute to the comprehension of the instrument's psychometric characteristics. In this research, we will study convergent and divergent validity, *e.g.*, the way in which measures of BRIEF- A and measures of cognitive, functionality, socio-affective and personality dimensions are related is tested, focusing on older adults (60+ years old).

Concerning socio-affective aspects, we will analyze the correlations between self-reports on the BRIEF-A and on the Geriatric Depression Scale - 30 Item (GDS-30) and between self-reports on the BRIEF-A and on the State-Trait Anxiety Inventory – Form Y (STAI-Y), similarly to what the authors did in the original study (Roth et al., 2005).

Furthermore, and aiming to contribute with other measures, we will explore the correlations between self-reports on the BRIEF-A and the cognitive dimension (performance) as measured by the Addenbrooke Cognitive Examination – Revised (ACE-R) and the Phonemic and Semantic Fluency test. Concerning functionality dimension, we will examine the correlations between self-reports on the BRIEF-A and the Adults and Older Adults Functional Assessment Inventory (IAFAI). We will also examine the correlation between self-reports on the BRIEF-A and the NEO Five Factor Inventory (NEO FFI), aiming to address the relation of personality and subjective executive functioning.

Additionally, we decided to explore the effects of demographical variables on the distribution of BRIEF-A parameters. Given the sample characteristics, we only referred to age.

IV. METHODS

1. Participants

The participants in this study were drawn from a convenience sample, from the center of Portugal. Data from 28 people and their informants (a total of 56 subjects) was collected. The informants must be over 18 years old, know the person well and have to be frequently in contact with the subject (see Roth et al., 2005).

All the participants (excluding informants) are 60 years old or over and have attended school for at least one year. As inclusion criteria, the subjects should be relatively independent, not institutionalized, cognitively preserved, having no antecedents of psychiatric illness or neurological disorder and no usage of psychotropic medication (see Roth et al., 2005). As exclusion criteria, we decided to exclude people with moderate cognitive decline, with severe incapacity, with severe depressive symptoms and who demonstrated insufficient effort.

Sample size was severely affected by the contingences imposed by COVID-19. Initially, the planned sample size was around 50 subjects. However, as the protocol demanded physical contact (specially in performance tests), sample collection had to be interrupted. Moreover, the sample was also limited geographically as circulation restrictions were imposed. So, given the reduced number of participants, some exceptions were made: one subject with severe functional incapacity was not excluded given the fact that the incapacity was due to a physical problem; one subject with severe depressive symptoms was not excluded because performance results did not demonstrate any cognitive decline, no incapacity was shown and the person showed sufficient effort; three participants were, however, excluded from the study because of moderate cognitive decline.

This being said, the final sample consisted of 25 participants and their informants (N total: 50 subjects).

2. Procedures and instruments

All participation was voluntary and consented by the subjects. When collecting and treating data all information was confidential and anonymous. The purpose of the study was explained to the participants, the voluntary nature of their participation was assured (explaining that they could give up at any point) and confidentially was guaranteed. Data was collected at the participants' home, individually, by Psychology Master's students specializing in Clinical Psychogerontology, securing the evaluation procedures. Whenever possible, self-report tests were answered by the subject itself. If there were visual, motor deficits present or comprehension difficulties (reading), self-report measures were answered by the subject in an interview format.

The complete evaluation of each participant lasted for around 2 hours, assuring the existence of breaks when needed (aiming to minimize fatigue effects).

The protocol followed included 9 instruments (briefly described below), in this order of application: **Brief semi-structured interview**; **Behavior Rating Inventory of Executive Function – Adult Version -** BRIEF-A (Roth et al., 2005; Portuguese studies: Lima 2019; Ribeiro, 2019); **Addenbrooke Cognitive Examination – Revised** - ACE-R (Firmino et al., 2017); **Phonemic Fluency – letters M** and **R** (Cavaco et al., 2013b); **Adults and Older Adults Functional Assessment Inventory** – IAFAI (Sousa et al., 2008); **Rey 15-Item Memory Test** - Rey 15-IMT (Simões et al., 2010); **NEO Five Factor Inventory** - NEO FFI (Pedroso-Lima et al., 2014); **State-Trait Anxiety Inventory (STAI) – Form Y** - STAI-Y (Silva, 2003); **Geriatric Depression Scale – 30 Item** - GDS-30 (Simões, Prieto et al., 2015).

This protocol was chosen in order to analyze the dimensions wanted (cognitive, functional, socio-affective and personalistic) while also intending not to be too extensive.

Brief semi-structured interview

Sociodemographic data about the subject was collected (age, gender, marital status, geographic region, education, working status/occupation) as well as personal and clinical history.

Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A)

As previously mentioned, the BRIEF-A is an inventory that addresses executive functioning in adults, aged 18 to 90 years old, through personal perspective and a significant one's personal perspective as well (the informant should be someone who is frequently in contact with the person) (Roth et al., 2005). The inventory has a self-report and an informant's version, each composed by 75 items. The person should answer according to the frequency of the problem for each item (1 = has never been a problem for me – 3 = has often been a problem for me), referring to the previous month (Roth et al., 2005).

There are **9 clinical scales** (Inhibition, Shift, Emotional Control, Self-Monitor, Initiate, Working Memory, Plan/Organize, Task Monitor and Organization of Materials), **2 indexes** (Behavioral Regulation Index and Metacognition Index - together form the Global Executive Composite) and **3 validity scales** (Negativity Scale, Infrequency Scale and Inconsistency Scale) (Roth et al., 2005).

When interpreting scores, higher results suggest more executive dysfunction (Roth et al., 2005).

The Portuguese version of this instrument was used (Lima, 2019; Ribeiro, 2019).

Addenbrooke Cognitive Examination – Revised (ACE-R)

The Addenbrooke Cognitive Examination is a brief cognitive assessment test, sensitive to initial demential processes and that also differentiates Alzheimer disease from Frontotemporal dementia. It evaluates five aspects of cognitive functioning [Attention and Orientation; Memory; Executive functions; Language; Visuospatial ability] and includes Mini Mental State Examination's items or similar tasks. The ACE-R has been successfully used in several clinical conditions. Higher scores suggest a better cognitive functioning (Firmino et al., 2017; Simões, Pinho et al., 2015).

Phonemic and Semantic Fluency Test

Fluency tests are used as indicators of non-motor processing speed, language production and executive functions (Cavaco et al., 2013b). Phonemic and semantic fluency tests seem to work in detecting subjects at risk of developing dementia, in identifying the ones who have already suffered some cognitive impairment and also in monitoring the progression of some diseases (see Cavaco et al., 2013b). In the Phonemic test the subject is asked to evoke as many words as possible starting with a specific letter (**P**, **M** and **R**) during 1 minute (one minute for each letter). In the Semantic test the subject is asked to evoke as many words as possible in a specific category (*e.g.* **Animals** – in this study, only this category was used) within 1 minute. Better results (more words evoked) are associated with younger age and more years of formal education (Cavaco et al., 2013b).

Adults and Older Adults Functional Assessment Inventory (IAFAI)

This inventory addresses daily activities through a structured interview and determines the degree to which the person is dependent or not. It is divided into three modules, which differ on the tasks' complexity: **Basic Activities of Daily Living** (Feeding; Dressing; Hygiene and Sphincter control; Mobility); **Instrumental Activities of Daily Living – Householding** (Conversation and Phone usage; Preparing meals; House caring; House safety); **Instrumental Activities of Daily Living – Advanced** (Comprehension and communication; Health-related decisions; Finances; Dislocation; Recreation). In addition to this, it is also addressed the nature of the limitation (whether it is physical, cognitive or emotional), possible facilitators (technical help or someone's help) and barriers to the execution of a certain task. The person should answer according to the dependence he/she faces for each task: independent without difficulty; independent with difficulty; dependent; not applicable. Whenever possible a version of the inventory should be answered by an informant (Sousa et al., 2008; Sousa, Prieto et al., 2015; Sousa, Vilar et al., 2015a, b).

It is possible to obtain a total for functional incapacity in each module, a percentage for global functional incapacity and a percentage for each cause: physical, cognitive or emotional. Higher results suggest more incapacity (Sousa et al., 2008; Sousa, Prieto et al., 2015; Sousa, Vilar et al., 2015a, b).

Rey 15-Item Memory Test (Rey 15-IMT)

The Rey 15-Item Memory Test is one of the most commonly used tests in detecting insufficient effort or deficit simulation (*malingering*). It is mainly used in forensic contexts but also for the validation of mnesic and/or attentional complaints in traditional clinical context (Simões et al., 2010; Vilar et al., 2017).

The task is divided into two stages: **Immediate recall** and **Recognition**. Results are interpreted according to Immediate recall and Combined result [Number of items recalled correctly + (Number of items signalized correctly – Number of items signalized incorrectly)]. Lower results suggest lack of motivation, insufficient effort or deficit simulation (Simões et al., 2010; Vilar et al., 2017).

NEO Five Factor Inventory (NEO FFI)

This inventory is a short version of the NEO-PI-R (NEO Personality Inventory-Revised) and it offers a representation of the individual's personality characteristics according to the Five Factor Model: **Openness**, **Conscientiousness**, **Extraversion**, **Agreeableness** and **Neuroticism** (McCrae& Costa, 1987). It has a total of 60 items (12 for each dimension), answered in a *likert* scale (0 = strongly disagree – 4 = strongly agree). Higher results in the dimensions suggest more marked personality characteristics congruent with that dimensions (Pedroso-Lima et al., 2014).

State-Trait Anxiety Inventory (STAI) – Form Y (STAI-Y)

This inventory is divided into two scales with 20 items each. The first scale evaluates anxiety at the moment – the subject is asked to choose the option that better describes the intensity of his/her feelings (**anxiety-state**) (Santos & Silva, 1997; Silva, 2003). The second evaluates anxiety usually felt – the subject is asked to choose the option that describes how he/she usually feels (**anxiety-trait**) (Santos & Silva, 1997; Silva, 2003). Answers are given in a *likert* scale. For the anxiety-state scale, 1 = "Not at All", 2 = "Somewhat", 3 = Moderately so" and 4 = "Very much so". For the anxiety-trait scale, 1= Almost never", 2= "Sometimes", 3= "Often" and 4 = "Almost always". Therefore, higher results suggest higher anxiety levels.

Geriatric Depression Scale – 30 Item (GDS-30)

This scale assesses affective and behavioral aspects of depression in older adults. The person must answer "Yes/No" having in mind the previous week. A higher score suggests more depressive symptoms (total score is 30). The final score can be interpreted the following way: scores between 0 and 10 suppose the absence of depressive symptoms, between 11 and 20 suppose slight depressive symptoms and between 21 and 30 suppose the existence of severe depressive symptoms (Simões, Prieto et al., 2015; Simões et al., 2017).

3. Statistical analysis

All data and relations between instruments were analyzed using the *Statistical Package for the Social Sciences – IBM SPSS Statistic 22* for Windows.

Descriptive statistics (mean, standard deviation, frequency, and range) were analyzed for sample characterization and for all tests results.

We resorted to Bivariate Pearson Correlations in order to examine the relations mentioned above. The correlation size characterization followed the suggested by Pestana and Gageiro (2008): $p = <0.2$ very low; between 0.2 and 0.39 low; between 0.4 and 0.69 moderate; between 0.7 and 0.89 high; between 0.9 and 1 very high. Additionally, a Mann Whitney U Test was ran to examine differences in the distribution of BRIEF-A parameters between two age groups. Results are significant at the $p = <.05$ level.

V. RESULTS

1. Sample characterization: Descriptive statistics

Table 1.

Sample characterization – Gender, age group, education, working status and marital status

Variables		N (%)	M (SD)	Min – Max
Gender	***Masculine***	9 (36,0%)		
	Feminine	16 (64,0%)		
Age group	***60-70***	13 (52,0%)	69.60 (8.231)	60 – 87
	+70	12 (48,0%)		
Education (Years)	***1 – 4***	13 (52,0%)		
	5 – 9	5 (20,0%)	7.84 (4.922)	3 – 19
	10 – 12	2 (8,0%)		
	+12	5 (20,0%)		
Working Status	***Active***	6 (24,0%)		
	Retired	19 (76,0%)		
Marital Status	***Married***	18 (72,0%)		
	Widowed	7 (28,0%)		
[Total]		[25]		

The final sample (N=25) was composed by 9 males (36,0%) and 16 females (64,0%). 13 subjects (52,0%) are between 60 and 70 years old and 12 (48,0%) are more than 70 years old. The age range varies between 60 and 87, the average being 69.60 years old (SD= 8.231). Concerning Education variable, 13 participants (52,0%) attended school for 1 to 4 years, 5 subjects (20,0%) for 5 to 9 years, 2 (8,0%) for 10 to 12 years and 5 (20,0%) for more than 12 years (M= 7.84; SD=4.922; Range: 3-19 years of education).

When referring to working status, 6 subjects (24%) are still active and 19 (76%) are currently retired. In appendix 1 there is some descriptive data about current or previous occupation. Finally, addressing marital status, 18 subjects (72,0%) are married while 7 (28,0%) are widowed.

Descriptive statistics of instruments – mean, standard deviation, and range – (BRIEF-A [Auto and Informant version], ACE-R, MMSE, Verbal Fluency Tests, IAFAI, Rey 15-IMT, NEO FFI, STAI-Y and GDS-30) can be consulted in appendix 2.

Additionally, frequencies of Negativity, Infrequency, and Inconsistency scales on the BRIEF-A Auto and Informant version are available in appendix 3. In the Self-report version, values ranged from 0 to 1 on the Negativity scale, from 0 to 2 on the Infrequency scale and from 0 to 6 on the Inconsistency scale. This results mean that responses were valid and acceptable (Roth et al., 2005). In the Informant-report version, values ranged from 0 to 4 in the Negativity scale, from 0 to 2 in the Infrequency scale and from 0 to 9 in the Inconsistency scale. Only one subject (4%) answered inconsistently (scoring 9), what lead to a careful revision of the report itself. Other responses were valid and acceptable.

2. Cognitive dimension

Table 2.

Correlations between BRIEF-A Self-report Indexes and Composite and ACE-R dimensions, MMSE Total, and Verbal Fluency Tests

	Behavioral Regulation Index (BRI)	Metacognition Index (MI)	Global Executive Composite (GEC)
ACE-R			
Total	.369	.032	.208
Attention and Orientation	-.363	-.376	**-.424***
Memory	.325	.129	.248
Executive functions	**.584****	.092	.355
Language	.280	.154	.241
Visuospatial ability	.009	-.186	-.113
MMSE			
Total	.271	-0.25	.122
Fluency tests			
Phonemic Verbal Fluency	.395	-.127	.121
Semantic Verbal Fluency	**.492***	.131	.334

**. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).*

Analyzing correlations between the BRIEF-A Self-report indexes/composite parameters and ACE-R dimensions, a significant moderate positive correlation was found between the BRI and Executive functions (.584). Also, a significant moderate negative correlation was found between GEC and Attention and Orientation (-.424).

However, when analyzing correlations between BRIEF-A clinical scales and ACE-R dimensions (see appendix 5), Emotional Control and Self-Monitor scales demonstrated a significant moderate positive correlation with ACE-R Total (.430 and .486, respectively). The Inhibit scale showed a significant moderate negative correlation with Attention and Orientation (-.596). Emotional Control (.641) and Self-Monitor (.562) scales demonstrated a significant moderate positive correlation with Executive functions. Finally, Self-Monitor scale exhibited a significant moderate positive correlation with Language (.418). All these BRIEF-A scales constitute the Behavioral Regulation Index (BRI).

Additionally, Initiate scale showed a significant moderate positive correlation with Memory (.465). Plan/Organize demonstrated a significant moderate negative correlation with Attention and Orientation (-.487). These scales are part of the Metacognition Index (MI) which, itself, did not correlate significantly with any dimensions of ACE-R.

No scales or indexes correlated significantly with MMSE Total (see table above and appendix 6).

When referring to Fluency tests and its correlation with BRIEF-A, a significant moderate positive correlation was found between Semantic Verbal Fluency test and BRI (.492). In fact, when including scales, Emotional Control (.537), Self-Monitor (.521) and Initiate (.398) showed significant moderate positive correlations with Semantic Verbal Fluency. Emotional Control also showed a significant moderate positive correlation with Phonemic Verbal Fluency (.557) (see appendix 6).

Correlations between BRIEF-A Informant report parameters and ACE-R dimensions, MMSE Total and Verbal Fluency Tests were analyzed in order to better comprehend previous findings obtained. These results are presented in appendix 8. Even if not many significant correlations were found, a clear pattern of negative relations is shown, suggesting that more executive functioning difficulties are negatively associated with cognitive performance in these tests. Moreover, correlations between BRIEF-A Self and Informant reports were also analyzed and presented in appendix 4.

3. Functionality dimension

Table 3.

Correlations between BRIEF-A Self-report Indexes and Composite and IAFAI dimensions

IAFAI	Behavioral Regulation Index (BRI)	Metacognition Index (MI)	Global Executive Composite (GEC)
Total	.054	.277	.203
Basic Activities of Daily Living	.102	.176	.164
Instrumental Activities of Daily Living - Householding	.049	.254	.186
Instrumental Activities of Daily Living - Advanced	-.005	.314	.197
Physical incapacity	.102	.202	.180
Cognitive incapacity	.025	.312	.211
Emotional incapacity	.[b]	.[b]	.[b]

. Correlation is significant at the 0.05 level (2-tailed).. Correlation is significant at the 0.01 level (2-tailed).*
b. Cannot be computed because at least one of the variables is constant.

Functionality and its relationship with executive functions was measured by evaluating correlations between IAFAI dimensions and BRIEF-A scales. No significant correlation was found between IAFAI dimensions and BRI, MI or GEC. However, Working Memory scale showed a significant moderate positive correlation with Instrumental Activities of Daily Living – Advanced (.427) and Cognitive incapacity (.419) (see appendix 7).

The Emotional incapacity variable could not be computed because results were constant. No subject referred any Emotional incapacity.

4. Socio-affective and personality dimension

Table 4.

Correlations between BRIEF-A Self-report parameters, and NEO FFI personalistic traits

Brief-A parameters	*Openness*	*Conscientiousness*	*Extraversion*	*Agreeableness*	*Neuroticism*
Inhibit	-.315	-.340	-.024	-.295	**.569****
Shift	-.371	**-.571****	**-.445***	-.009	**.432***
Emotional Control	.063	.142	.065	-.304	.258
Self-Monitor	-.084	-.273	-.039	-.114	**.508***
Behavioral Regulation Index (BRI)	-.178	-.255	-.117	-.247	**.518****
Initiate	.028	**-.414***	-.219	.073	.159
Working Memory	-.200	**-.702****	**-.422***	.096	.321
Plan/Organize	-.003	**-.637****	.109	-.133	.322
Task Monitor	-.044	**-.590****	-.073	-.152	**.462***
Organization of Materials	-.099	**-.636****	-.021	-.198	**.447***
Metacognition Index (MI)	-.074	**-.719****	-.125	-.085	**.411***
Global Executive Composite (GEC)	-.138	**-.586****	-.139	-.180	**.524****

. Correlation is significant at the 0.05 level (2-tailed).. Correlation is significant at the 0.01 level (2-tailed).*

In order to understand how personality traits might influence executive functioning, correlations between NEO FFI traits and BRIEF-A parameters were made. Openness and Agreeableness did not show any significant correlations with BRIEF-A parameters. Extraversion demonstrated two significant moderate negative correlations: with Shift (-.445) and with Working Memory (-.422).

Conscientiousness trait showed moderate negative correlations with Shift (-.571), Initiate (-.414), Plan/Organize (-.637), Task Monitor (-.590), Organization of Materials (-.636).

It also showed a moderate negative correlation with Global Executive Composite (GEC) (-.586). Additionally, two high negative correlations were found between Conscientiousness and Working Memory (-.702) and between Conscientiousness and Metacognition Index (MI) (-.719).

Neuroticism trait demonstrated significant moderate positive correlations with Inhibit (.569), Shift (.432), Self-Monitor (.508) and with BRI (.518). It also showed significant moderate positive correlations with Task Monitor (.462), Organization of Materials (.447) and with MI (.411). Finally, a similar correlation was also found between Neuroticism and GEC (.524).

Table 5.

Correlations between BRIEF-A Self-report parameters, and STAI-Y (State/Trait) and GDS-30

BRIEF-A parameters	*STAI-Y State*	*STAI-Y Trait*	*GDS-30*
Inhibit	.347	**.573****	**.469***
Shift	.086	.341	.292
Emotional Control	.068	.236	-.163
Self-Monitor	.250	.386	.168
Behavioral Regulation Index (BRI)	.206	**.451***	.166
Initiate	-.068	.292	.140
Working Memory	.342	**.541****	**.413***
Plan/Organize	.170	**.474***	.388
Task Monitor	.278	**.615****	.377
Organization of Materials	.229	**.490***	**.576****
Metacognition Index (MI)	.232	**.577****	**.462***
Global Executive Composite (GEC)	.252	**.596****	.378

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

The relationship between BRIEF-A scales, STAI-Y and GDS-30 was also investigated. Between BRIEF-A and STAI-Y State no significant correlations were found.

However, between BRIEF-A and STAI-Y Trait significant moderate positive correlations were found for Inhibit (.573) and BRI (.451). Similar significant moderate positive relations were found for every scale of the Metacognition Index and the index itself: Working Memory (.541), Plan/Organize (.474), Task Monitor (.615), Organization of

Materials (.490) and Metacognition Index (.577). Finally, a significant moderate positive correlation was showed for GEC (.596).

Between BRIEF-A scales and GDS-30 Total, significant moderate positive correlations were found for Inhibit (.469), Working Memory (.413), Organization of Materials (.576) and Metacognition Index (.462).

5. Differences between age groups in BRIEF-A parameters

Table 6.

Differences between age groups in the distribution of BRIEF-A Self-report parameters

			60-69 years old (N=13)		***70+ years old (N=12)***	
BRIEF-A parameters	***U***	***p***	***Mean Rank***	***Sum of Ranks***	***Mean Rank***	***Sum of Ranks***
Inhibit	37.500	**.025***	16.12	209.50	9.63	115.50
Shift	51.500	.143	15.04	195.50	10.79	129.50
Emotional Control	17.000	**.001***	17.69	230.00	7.92	95.00
Self-Monitor	47.000	.087	15.38	200.00	10.42	125.00
Behavioral Regulation Index (BRI)	18.500	**.001***	17.58	228.50	8.04	96.50
Initiate	64.000	.436	14.08	183.00	11.83	142.00
Working Memory	75.500	.890	13.19	171.50	12.79	153.50
Plan/Organize	47.500	.090	15.35	199.50	10.46	125.50
Task Monitor	52.500	.160	14.96	194.50	10.88	130.50
Organization of Materials	73.000	.782	13.38	174.00	12.58	151.00
Metacognition Index (MI)	55.000	.210	14.77	192.00	11.08	133.00
Global Executive Composite (GEC)	37.000	**.025***	16.15	210.00	9.58	115.00

*$p<0.05$

In order to better comprehend differences between age groups (60-69 years old and 70 or more years old) in the distribution of BRIEF-A scales, a Mann-Whitney U Test was used additionally. Results obtained suggest that there are differences between these two age groups on the Inhibit scale (U=37.500; p= .025), Emotional Control scale (U= 17.000; p= .001), Behavioral Regulation Index (U= 18.500; p= .001) and Global Executive Composite (U= 37.000; p= .025). It is also clear by analyzing mean rank values that the younger group tends to report more perceived difficulties in executive functioning. A table with these findings is presented above (Table 6).

VI. DISCUSSION

1. Cognitive dimension

Initially, a brief cognitive assessment test (ACE-R) was included in order to exclude impaired subjects from the final sample, which aimed to include only preserved individuals from the community. However, when analyzing data obtained by correlating BRIEF-A scales and ACE-R dimensions the findings were surprising.

We would expect to observe a negative correlation between BRIEF-A scales and ACE-R dimensions, meaning that less perceived difficulties in executive functioning are associated with better cognitive performance (Pires et al., 2016; Roth et al., 2005). However, that did not happen and significant positive correlations were found between some scales (mainly Emotional Control and Self-Monitor) and cognitive dimensions (ACE-R's Executive functions and Semantic Verbal Fluency) (see appendix 5 and appendix 6). The only exception was with Attention and Orientation, which correlated significantly and negatively with some scales (Inhibit, Plan/Organize and GEC), meaning that less perceived difficulties in executive functioning are associated with more preserved attentional and orientational abilities (see appendix 5).

We hypothesized that this might have happened because perceptions of executive functioning and actual cognitive performance might have discrepancies. Someone may have insight over his/her difficulties and report them ("My mood changes frequently") even if his/her performance in cognitive assessment is apparently preserved. In fact, it seems comprehensible that when someone is cognitively preserved, recognition of existing difficulties is also clearer (Roth et al., 2005).

However, it is important to refer that difficulties reported in BRIEF-A do not seem to have clinical significance – even though norms for Portuguese population are not available yet – and are relatively low throughout the sample (see mean values in appendix 2). It is also important to refer that Emotional Control scale has the highest mean value (M= 14,88) (see appendix 2) and is the scale that correlated the most with ACE-R's Executive functions dimension (.641). This might indicate that participants perceive more difficulties in emotional control, even if cognitive performance is preserved. Items that evaluate emotional control refer to some behaviors that might not be visible to others, such as "I overreact to small problems", "My mood changes frequently" and "People say

I’m too emotional”. Self-Monitor scale also correlated significantly with ACE-R’s Total Executive functions and Language dimension (.562). Items included in this scale are, for example, “When people seem upset with me, I don’t understand why” and “I say things without thinking”. Once again, this finding might suggest that perceived difficulties in monitoring his/her own behavior or the effect of his/her behavior on others (Roth et al., 2005) are not reflected in cognitive performance results. In fact, most significant correlations between BRIEF-A scales and ACE-R dimensions are between scales that compose the Behavioral Regulation Index, that mainly evaluates the ability to regulate and control behavior and emotional responses (Roth et al., 2005). These results can also support the characterization of “cold” and “hot” executive functions. The first ones include abilities such as planning and cognitive flexibility, whereas the second ones include emotional and motivational aspects of executive functioning (Hagen et al., 2016). In fact, Isquith et al. (2013) have stated that rating scales of executive functions might not consistently correlate to convergent performance measures because they might evaluate different aspects of executive functioning: rating scales might evaluate “hot” aspects while performance measures might evaluate “cold” cognitive ones (Isquith et al., 2013).

To better comprehend these findings, correlations between BRIEF-A Informant reports and ACE-R dimensions, MMSE and Verbal Fluency Tests were also analyzed (appendix 8). Even if not many significant correlations were found, the negative pattern of relations is clear. This suggests that informants report less perceived executive difficulties about the person they are evaluating, and that less perceived executive difficulties are associated with better cognitive performance. Additionally, correlations between Informant reports and Self-report forms (appendix 4) showed that perceptions do differ between the two subjects. It is important to mention that answers in both forms are valid and acceptable (see appendix 3). These divergent results stress the importance of having several informants throughout neuropsychological assessment and also the need to articulate between ones’ subjective perception and cognitive performance itself (Bell et al., 2019; Roth et al., 2005; Simões et al., 2016).

To complement these findings, we decided to analyze whether there existed differences on difficulties reported in BRIEF-A between two age groups: 60-70 and +70 years old. To do so a Mann-Whitney U test was used, and differences do seem to exist, as mentioned before (see table 6). The distribution differs in the Inhibit scale, in the Emotional Control scale, in the BRI and, finally, in the GEC (see table 4). It is clear when analyzing mean ranks between groups (see table 4) that younger adults report more perceived executive functioning difficulties. This also reinforces the hypothesis that even if cognitive performance is preserved, difficulties in executive functioning are reported by some participants, mainly belonging to the younger age group, what might be due to a better difficulty insight.

In fact, and including a more subjective report, some participants did mention the existence of executive difficulties to the evaluators throughout the evaluation process, mainly addressing memories difficulties (“I forget things a lot”; “I sometimes lose things because I do not remember where I put them”).

Other hypothesis considered to justify the discrepancy between difficulties reported in BRIEF-A and performance in ACE-R is that cognitive reserve is inflating results in the cognitive performance test. When analyzing current and previous occupation we conclude that not only 24% of the sample is still actively working but also that occupations are heterogeneous, varying in cognitive demand (see table 1 and appendix 7). In addition to this, years of formal schooling also vary from 3 to 19 years (see table 1). This suggests that if reported difficulties are congruent with cognitive performance, cognitive reserve might be influencing results in the cognitive performance test and existing impairment might not be visible yet in the results. However, it is important to stress that this is a sample drawn from the community and where functionality is strongly preserved (Fouber-Samier et al., 2012; IOM, 2015; Stern, 2009, 2012).

Additionally, findings do not seem to be a result of a lack of involvement in the tasks proposed, as results in Rey 15-IMT (appendix 2) were acceptable.

The reduced sample size is also a limitation and might be influencing results obtained. Results might also be influenced by the existing relationship between participants and evaluators, which might have resulted in the evaluation process becoming an outburst space for some participants.

2. Functionality dimension

Throughout the theoretical framework we mentioned that executive functioning strongly influences daily functionality (Bell-McGinty et al., 2002; Cahn-Weiner et al., 2010; McAlister & Schmitter-Edgecombe, 2016), so we would expect significant correlations between BRIEF-A dimensions (which measure perceived difficulties in executive functioning) and IAFAI variables (which measure perceived difficulties in daily functionality). However, globally that did not happen. As mentioned before, only two significant moderate positive correlations were found between BRIEF-A dimensions and IAFAI variables: Working Memory and Instrumental Activities of Daily Living – Advanced and Working Memory and Cognitive incapacity (see appendix 7).

This might have happened due to the sample's average age (see table 1) and preserved functionality – most people are 60 to 70 years old and do not report significant incapacities on daily living. As presented in appendix 2, the mean in every IAFAI's dimension is extremely low (for example, for IAFAI Total M= 4,055). Nevertheless, as expected, Activities of Daily Living – Advanced, which are more exigent and complex activities that require higher levels of cognitive functioning (such as driving, managing finances, making important decisions) (Sousa et al., 2008), correlated significantly with one dimension of BRIEF-A – Working Memory scale. This means that more perceived difficulties in Working Memory – the ability to keep in mind information necessary to complete a task or give a response (Roth et al., 2005) – are associated with more difficulties in Advanced Activities of Daily Living.

The correlations observed with BRIEF-A's Working Memory subscale are congruent with memory complaints expressed by participants on IAFAI's items. These complaints were not only reported on the instrument but also expressed to the evaluators (see previous section).

Another aspect important to mention in order to understand results obtained is that this sample includes only healthy people living in community, so we would not expect to encounter high levels of impairment on daily living tasks whatsoever (Marson & Hebert, 2006).

Summarizing, more perceived executive functioning difficulties, specifically in respect to working memory, also represent more difficulties in daily functioning (mainly in advanced daily living activities) and more cognitive incapacity.

In addition to this, it is important to refer that the variable "Emotional incapacity" could not be computed because no subject in the study reported having emotional incapacities.

However, once again, the small size of the sample might also justify the results obtained.

3. Socio-affective and personality dimension

Executive functioning and socio-affective aspects were analyzed by addressing correlations between BRIEF-A parameters and NEO FFI dimensions. Higher scores in BRIEF-A parameters stand for more perceived difficulties in executive functioning and higher scores in NEO FFI dimensions imply a more marked personalistic trait.

Openness did not show any significant correlations with BRIEF-A, however, almost every subscale, index (BRI and MI) and composite (GEC) (except Emotional Control and Initiate) demonstrate negative relations – although not statistically significant – with this trait.

Agreeableness did not demonstrate any significant correlations with BRIEF-A either. However, once again, almost every subscale, index and composite had negative relations with this personalistic trait, except for Initiate and Working Memory.

Shift and Working Memory had two negative significant correlations with Extraversion (-.445 and -.422, respectively), what suggests that a more marked personalistic trait of Extraversion is associated with less difficulties in making transitions, problem solving, and changing focus and also in actively remembering information (Campbell et al., 2011; Roth et al., 2005).

The negative pattern of correlations between these traits (Openness, Agreeableness and Extraversion) and BRIEF-A, even if not significant, might suggest the existence of a protective effect in respect to cognitive functioning (Wilson et al., 2007).

Conscientiousness demonstrated moderate and high negative correlations with several scales of BRIEF-A, as well as with MI and GEC. The high negative correlation suggested that a more marked personalistic trait is associated with less problems in controlling attention and solving problems (Roth et al., 2005). Nevertheless, when referring to BRI and the scales that compose this index, only a significant negative moderate correlation was found with Shift. This means that there is not a marked association between this trait and this index, that represents regulatory control and that is suggested to be present in people with high Conscientiousness. However, the pattern of significant moderate and high negative correlations between this personalistic trait and perceived executive functioning difficulties underlines its protective effect that is suggest by literature (Wilson et al., 2007).

Finally, Neuroticism is positively associated with many scales, with BRI, MI and GEC. This finding suggests and confirms what has been noted in literature, that a more marked personalistic trait characterized by negative affect, worrying, anxiety and stress is associated with more cognitive difficulties – in this case, with more perceived difficulties in executive functioning (Luu et al., 2000; Williams et al., 2010; Wilson et al., 2007). This is an interesting finding because it emphasizes the importance of including personality tests in cognitive assessment, as marked Neuroticism traits are significantly associated to cognitive impairment and the development of certain diseases, such as Alzheimer disease (Williams et al., 2010; Wilson et al., 2007).

Executive functioning and socio-affective aspects were also addressed by investigating the existent relations between BRIEF-A parameters, STAI-Y (State and Trait) and GDS-30, similarly to what the authors did in the original study.

Differently from what was found by the authors Roth el al. (2005), no significant relation was found between BRIEF-A scales, index, or composite and STAI-Y State (which represents acute feeling of worry, tension and nervousness (Roth et al., 2005)). This suggests that participants were not significantly experiencing these feelings when the evaluation took place.

However, significant moderate positive relations were found between several clinical scales, BRI, MI and GEC and STAI-Y Trait, that represents a more chronic presence of these feelings (Roth et al., 2005). A similar pattern of relations was shown in the original study (Roth et al., 2005). In fact, the authors highlight that the relationships found between BRIEF-A and State anxiety are smaller than the ones found with Trait anxiety. This finding suggests that a more continuous presence of anxiety (anxiety as a trait) is associated with more perceived difficulties in executive functioning, what is congruent with was also found when analyzing BRIEF-A variables and NEO FFI dimensions – Neuroticism, a trait strongly characterized by feelings of preoccupation, anxiety and tension, also seems to be associated with more perceived difficulties in executive functioning (Denburg et al., 2009; Luu et al., 2000).

In addition to this, significant moderate positive correlations were found between GDS-30 and Inhibit, Working Memory, Organization of Materials and Metacognition Index, suggesting that more depressive symptoms are associated with more perceived difficulties in executive functioning (Kang et al., 2014; Rosselli et al., 2019). The relationships found were not as notable as the ones found by Roth et al. (2005), which demonstrated significant moderate positive correlations with every variable of BRIEF-A. Nevertheless, it is clear that the presence of these symptoms (for at least one week, as evaluated by GDS-30) is associated with difficulties in executive functioning and if these feelings are chronic results are also congruent with the ones obtained for Neuroticism.

VII. CONCLUSION

The present study aimed to contribute to the validation of the BRIEF-A for the Portuguese population, specifically focusing on convergent and divergent validity. Additionally, it focused only on healthy older adults living in the community. We expected that BRIEF-A parameters would correlate well with executive functions' measures and less well with other measures such as anxiety or depression (Roth et al., 2005). Even if this relation was not clear for the cognitive performance measures used in this study or for the functionality measure, for the personality dimension the pattern found was visible and the same happened for anxiety and depressive symptoms – some correlations found between BRIEF-A parameters and STAI-Y Trait and GDS-30 were similar to the ones demonstrated by the authors Roth et al. (2005).

Findings in this study were extremely interesting, mainly in respect to the clear relation between difficulties in executive functioning, personality traits, anxiety, and depressive symptoms. It also emphasized the importance of having several informants throughout neuropsychological assessment and the importance of using different instruments (*e.g.* rating scales and performance tests).

Some unexpected results also appeared in the present study, concerning convergent validity through performance tests. Nevertheless, these findings demand more investigation and more exigent justifications.

This research has several limitations as well. The sample size had to be reduced due to COVID-19 contingencies, even more given the fact that participants were +60 years old (therefore belonging to a vulnerable group). Also, the sample was only drawn from the center of Portugal, what means that it is not representative of the whole country. This being said, results obtained are severely limited and more research should be conducted with a larger sample.

Additionally, the protocol followed should also suffer some alterations. First, and given the results obtained, some other performance test that evaluates executive functioning (*e.g*, Trail Making Test, Clock Drawing Test, Stroop Test, Iowa Gambling Task) should be included to complement findings – we only included the ACE-R and Verbal Fluency Tests due to the protocol's extension and because this study is included in a wider validation process where other cognitive performance tests have been used. Secondly, the

Geriatric Anxiety Inventory (Daniel et al., 2015; Ribeiro et al., 2011) would be more adequate than STAI-Y to this specific population. However, the authors demanded the inclusion of at least two instruments also present in the original study (Roth et al., 2005), and we opted for STAI-Y and GDS-30.

The influence of other variables such as education and gender should be studied as well in order to contribute for the establishment of norms. Analysis to explore the existence of moderating variables (such as personality traits, for example) should also be developed.

Despite the existence of these limitations, this study offers an initial contribute to the analysis of BRIEF-A convergent and divergent validity with Portuguese population (specifically with healthy individuals from the community), that should be complemented with other instruments and expanded to clinical groups (*e.g.* Parkinson's disease, Mild Cognitive Impairment). It might also contribute to an initial establishment of norms for the Portuguese population assuming that this study is replicated using a wider and more representative sample.

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IX. APPENDIX

APPENDIX

Appendix 1.

Sample characterization – current or previous occupation

	Frequency	Percent	Valid Percent	Cumulative Percent
Medical care assistant	1	4,0	4,0	4,0
Elderly care home assistant	2	8,0	8,0	12,0
Bank worker	1	4,0	4,0	16,0
Cashier	1	4,0	4,0	20,0
Accountant	1	4,0	4,0	24,0
Seamstress	1	4,0	4,0	28,0
Housekeeper	4	16,0	16,0	44,0
Factory worker	2	8,0	8,0	52,0
Metallurgical worker	1	4,0	4,0	56,0
Military worker	2	8,0	8,0	64,0
Driver	1	4,0	4,0	68,0
Painter worker	1	4,0	4,0	72,0
Teacher (male)	1	4,0	4,0	76,0
Teacher (female)	4	16,0	16,0	92,0
Post-office worker	1	4,0	4,0	96,0
Environmental health technician	1	4,0	4,0	100,0
Total	25	100,0	100,0	

Appendix 2.

Descriptive statistics – Profile results in BRIEF-A (Self and Informant Report versions), ACE-R, MMSE. Verbal Fluency, IAFAI, Rey 15-IMT, NEO-FFI, STAI-Y and GDS-30

BRIEF-A Self Report

	N	Minimum	Maximum	Mean	Std. Deviation
Inhibit	25	8	14	10,40	1,732
Shift	25	6	13	9,36	2,119
Emotional Control	25	10	20	14,88	3,383
Self-Monitor	25	6	12	8,60	1,848
BRI	25	30	57	43,24	7,161
Initiate	25	8	15	9,84	1,724
Working Memory	25	8	16	10,52	2,044
Plan/Organize	25	10	21	12,68	2,824
Task Monitor	25	6	12	8,44	1,895
Organization of Materials	25	8	16	10,60	2,121
MI	25	42	78	52,08	8,925
GEC	25	73	125	95,32	14,064
Valid N (listwise)	25				

BRIEF-A Informant Report

	N	Minimum	Maximum	Mean	Std. Deviation
Inhibit	25	8	19	10,60	2,930
Shift	25	6	17	9,44	2,551
Emotional Control	25	10	28	15,84	4,723
Self-Monitor	25	6	17	8,92	3,316
BRI	25	32	78	44,80	11,737
Initiate	25	8	16	10,08	2,326
Working Memory	25	8	18	11,60	2,500
Plan/Organize	25	10	21	12,92	3,013
Task Monitor	25	6	11	8,28	1,514
Organization of Materials	25	8	21	10,28	3,116
MI	25	41	79	53,16	9,848
GEC	25	74	149	97,96	18,873
Valid N (listwise)	25				

ACE-R and MMSE

	N	Minimum	Maximum	Mean	Std. Deviation
ACE-R Total	25	65	95	83,32	8,625
Attention and Orientation	25	16	18	17,72	,614
Memory	25	10	26	18,64	4,654
Executive functions	25	4	14	8,92	2,857
Language	25	17	26	23,64	2,289
Visuospatial ability	25	10	16	13,96	1,428
MMSE Total	25	25	30	28,16	1,375
Valid N (listwise)	25				

Verbal Fluency Tests

	N	Minimum	Maximum	Mean	Std. Deviation
Phonemic Verbal Fluency	25	11	65	27,32	12,964
Semantic Verbal Fluency	25	7	24	15,76	4,136
Valid N (listwise)	25				

IAFAI

	N	Minimum	Maximum	Mean	Std. Deviation
IAFAI Total	25	,00	34,68	4,0552	9,163
IAFAI BADLs Total	25	,00	12,24	1,1536	3,011
IAFAI IADLs Household Total	25	,00	16,32	1,5248	4,102
IAFAI IADLs Advanced Total	25	,00	13,33	1,3768	3,075
IAFAI Physical incapacity	25	,00	26,53	2,5656	6,432
IAFAI Cognitive incapacity	25	,00	20,00	1,8108	4,328
IAFAI Emotional incapacity	25	,00	,00	,0000	,000
Valid N (listwise)	25				

Rey 15-IMT

	N	Minimum	Maximum	Mean	Std. Deviation
Immediate Recall	25	6	15	11,72	3,234
Recognition	25	9	30	23,00	6,298
Valid N (listwise)	25				

NEO FFI

	N	Minimum	Maximum	Mean	Std. Deviation
Openness	25	11	38	27,80	6,958
Conscientiousness	25	25	47	37,00	5,370
Extraversion	25	9	37	25,68	5,886
Agreeableness	25	20	45	34,76	5,995
Neuroticism	25	6	37	24,76	7,886
Valid N (listwise)	25				

STAI-Y and GDS-30

	N	Minimum	Maximum	Mean	Std. Deviation
STAI-Y State	25	20	57	30,16	8,635
STAI-Y Trait	25	20	49	36,32	8,138
GDS-30 Total	25	0	21	8,36	4,898
Valid N (listwise)	25				

Appendix 3.

Frequencies – BRIEF-A Validity Scales (Self and Informant Report versions)

Negativity Scale – Self-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	24	96,0	96,0	96,0
1	1	4,0	4,0	100,0
Total	25	100,0	100,0	

Infrequency Scale – Self-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	15	60,0	60,0	60,0
1	8	32,0	32,0	92,0
2	2	8,0	8,0	100,0
Total	25	100,0	100,0	

Inconsistency Scale – Self-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	3	12,0	12,0	12,0
1	4	16,0	16,0	28,0
2	9	36,0	36,0	64,0
3	1	4,0	4,0	68,0
4	4	16,0	16,0	84,0
5	2	8,0	8,0	92,0
6	2	8,0	8,0	100,0
Total	25	100,0	100,0	

Negativity Scale – Informant-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	22	88,0	88,0	88,0
2	1	4,0	4,0	92,0
4	2	8,0	8,0	100,0
Total	25	100,0	100,0	

Infrequency Scale – Informant-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	13	52,0	52,0	52,0
1	11	44,0	44,0	96,0
2	1	4,0	4,0	100,0
Total	25	100,0	100,0	

Inconsistency Scale – Informant-Report Version

	Frequency	Percent	Valid Percent	Cumulative Percent
0	4	16,0	16,0	16,0
1	5	20,0	20,0	36,0
2	3	12,0	12,0	48,0
3	7	28,0	28,0	76,0
4	3	12,0	12,0	88,0
5	1	4,0	4,0	92,0
6	1	4,0	4,0	96,0
9	1	4,0	4,0	100,0
Total	25	100,0	100,0	

Appendix 4.

Correlations between BRIEF-A Self and Informant Report parameters

BRIEF-A parameters	*Inhib Info.*	*Shift Info.*	*EC Info.*	*SM Info.*	*BRI Info.*	*Initiate Info.*	*WM Info*	*P/O Info.*	*TM Info.*	*OoM Info.*	*MI Info.*	*GEC Info.*
Inhib Self.	.369	.166	**.502***	.347	**.428***	.033	.154	.142	.273	.025	.140	.340
Shift Self.	-.050	-.169	.023	-.073	-.061	.053	.091	.109	.175	.167	.149	.040
EC Self.	-.110	-.201	.181	.051	.016	-.136	-.164	-.132	-.164	.059	-.121	-.053
SM Self.	.092	.057	.269	.192	.198	-.070	.045	.114	.295	.179	.132	.192
BRI Self.	.046	-.090	.283	.136	.144	-.059	-.001	.034	.117	.129	.055	.118
Initiate Self.	-.030	.111	-.014	.049	.025	.273	.004	.190	.114	.365	.257	.150
WM Self.	.308	.274	.151	.302	.282	**.543****	**.491***	**.528****	**.490***	.362	**.604****	**.491***
P/O Self.	.226	.067	.280	.375	.290	.258	.199	.315	.256	**.418***	.379	.378
TM Self.	.251	.096	.283	.331	.291	.200	.303	**.408***	**.449***	**.430***	**.454***	**.418***
OoM Self.	.174	-.089	.160	.185	.141	.125	.212	.223	.166	**.478***	.328	.259
MI Self.	.231	.105	.219	.311	.256	.331	.291	**.397***	.350	**.491***	**.482***	**.411***
GEC Self.	.170	.020	.283	.267	.236	.180	.184	.269	.281	.377	.334	.321

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 5.

Correlations between BRIEF-A parameters and ACE-R dimensions

BRIEF-A parameters	***ACE-R Total***	***ACE-R Attention and Orientation***	***ACE-R Memory***	***ACE-R Executive functions***	***ACE-R Language***	***ACE-R Visuospatial ability***
Inhibit	.052	**-.596****	.122	.217	.080	-.111
Shift	.110	-.240	.115	.280	.217	-.119
Emotional Control	**.430***	-.177	.354	**.641****	.188	.120
Self-Monitor	**.468***	-.250	.365	**.562****	**.418***	.057
BRI	.369	-.363	.325	**.584****	.280	.009
Initiate	.368	-.083	**.465***	.293	.323	-.003
W.Memory	-.111	-.377	-.028	.007	.122	-.364
Plan/Organize	-.044	**-.487***	.064	.002	.046	-.148
Task Monitor	.111	-.284	.123	.284	.144	-.132
Org.Materials	-.097	-.250	-.003	-.116	.081	-.116
MI	.032	-.376	.129	.092	.154	-.186
GEC	.208	**-.424***	.248	.355	.241	-.113

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 6.

Correlations between BRIEF-A parameters and Verbal Fluency Tests and MMSE Total

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

BRIEF-A parameters	***MMSE Total***	***Phonemic Verbal Fluency***	***Semantic Verbal Fluency***
Inhibit	.042	.096	.142
Shift	.165	.067	.234
Emotional Control	.363	**.557****	**.537****
Self-Monitor	.157	.346	**.521****
BRI	.271	.395	**.492***
Initiate	.240	.032	**.398***
Working Memory	-.238	-.203	.015
Plan/Organize	.024	-.193	.104
Task Monitor	.036	.081	.205
Org.Materials	-.134	-.180	-.106
MI	-.025	-.127	.131
GEC	.122	.121	.334

Appendix 7.

Correlations between BRIEF-A parameters and IAFAI dimensions

BRIEF-A parameters	*IAFAI Total*	*BADLs*	*IADLs - Householding*	*IADLs - Advanced*	*Physical incapacity*	*Cognitive incapacity*	*Emotional incapacity*
Inhibit	.003	.005	-.010	.099	.019	.107	.[b]
Shift	.260	.252	.236	.211	.275	.237	.[b]
Emo.Control	-.162	-.058	-.106	-.285	-.083	-.241	.[b]
Self-Monitor	.180	.208	.124	.168	.212	.167	.[b]
BRI	.054	.102	.049	-.005	.102	-.025	.[b]
Initiate	.099	.133	.118	.009	.136	.060	.[b]
W.Memory	.352	.235	.294	**.427***	.257	**.419***	.[b]
Plan/Organize	.151	.048	.051	.199	.060	.211	.[b]
Task Monitor	.325	.180	.329	.354	.217	.349	.[b]
Org.Materials	.256	.182	.196	.323	.218	.269	.[b]
MI	.277	.176	.254	.314	.202	.312	.[b]
GEC	.203	.164	.186	.197	.180	.211	.[b]

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).
b. Cannot be computed because at least one of the variables is constant.

Appendix 8.

Correlations between BRIEF-A Informant report parameters and ACE-R dimensions, MMSE Total and Verbal Fluency Tests

ACE-R and BRIEF-A Informant report

BRIEF-A Informant report parameters	***ACE-R Total***	***ACE-R Attention and Orientation***	***ACE-R Memory***	***ACE-R Executive functions***	***ACE-R Language***	***ACE-R Visuospatial ability***
Inhibit	-.160	**-.436***	-.002	-.168	.021	-.293
Shift	-.168	-.158	.010	-.235	-.136	-.121
Emotional Control	-.127	**-.404***	-.012	-.063	-.071	.042
Self-Monitor	-.044	**-.462***	.152	-.080	.023	-.150
BRI	-.140	**-.436***	.040	-.141	-.046	-.125
Initiate	-.128	-.217	-.013	-.175	.107	-.162
W.Memory	-.264	-.239	-.260	-.285	-.004	-.273
Plan/Organize	-.156	-.215	-.088	-.165	.026	-.078
Task Monitor	-.211	-.226	-.162	-.120	-.066	-.264
Org.Materials	.077	.021	.114	.012	.155	.059
MI	-.153	-.206	-.085	-.179	.071	-.154
GEC)	-.167	-.379	-.020	-.181	.008	-.158

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).

MMSE Total, Verbal Fluency Tests and BRIEF-A Informant report

BRIEF-A parameters Informant report	***MMSE Total***	***Phonemic Verbal Fluency***	***Semantic Verbal Fluency***
Inhibit	-.211	-.116	-.242
Shift	-.152	-.245	-.262
Emotional Control	-.022	-.091	-.141
Self-Monitor	-.061	-.108	-.162
BRI	-.112	-.149	-.220
Initiate	-.226	-.257	-.171
Working Memory	-.369	**-.439***	**-.449***
Plan/Organize	-.208	-.289	-.175
Task Monitor	-.223	-.232	-.248
Organization of Materials	-.050	-.229	.047
MI	-.260	-.369	-.231
GEC	-.205	.285	-.257

*. Correlation is significant at the 0.05 level (2-tailed).**. Correlation is significant at the 0.01 level (2-tailed).