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LETTER TO THE EDITOR

A model of sensory, emotional, and cognitive reserve

We read with interest Stern's Cognitive Reserve (CR) model (2012) and his works along the years. According to Stern, CR proxies refer to different individual cognitive and socio-behavioral factors with impact on the adaptation of cognitive processes to aging, brain pathology or injury (Stern, 2002, 2009; Stern et al., 2019). However, Stern's model of CR is focused on cognition and the influence of sensory or emotional aspects was not considered. Thus, we propose a model of Sensory, Emotional, and Cognitive Reserve (SEC reserve model) in which CR, sensory reserve (SR), and emotional reserve (ER) interact with each other, reducing the impact of neuropathology caused by brain disease and injury. Therefore, higher levels of SEC reserve hold the potential to enhance rehabilitation outcomes and prevent or delay the impact of neurocognitive deficits on functionality in the instrumental cognitive activities of daily life.

It is surprising that these dimensions are not considered in the assessment of CR given the interdependence between cognition, emotion, and sensation: (a) the sensory deficit theory postulates the interaction between cognitive and sensory functioning (Humes & Young, 2016); and (b) the integration of bottom-up (sensory-driven) and top-down processes (mediated by cognitive control) into emotional (Kajal et al., 2020) and perceptual processing (Riener, 2019). In other words, cognitive processes arise from the transformation of sensory inputs that allow mapping the external world (Mesulam, 1998). In turn, sensory processes are influenced by both cognitive and emotional states (e.g., fear reduces tactile sensitivity) (Kelley & Schmeichel, 2014). Emotion states influences relevant cognitive processes (Harlé et al., 2013), such as allocation of attention and inhibitory control, in the same way neurocognitive functioning influence emotional regulation (e.g., executive impairment can partially relate to effective emotion regulation) (Mohammed et al., 2022). Thus, the proposed SEC model assumes the interdependence and interaction between three types of reserve: CR, SR, and ER (see Figure 1).

Regarding SR, to the best of our knowledge, this is the first time that this term is being specifically proposed. However, the concept of auditory reserve has previously been explored in a study by Skoe and Kraus (2014), which was defined as the "ability to develop and maintain robust subcortical and cortical auditory functioning that enables an individual to preserve auditory processing abilities when faced with acoustically-challenging conditions and maintain robust sound-to-meaning connections when afflicted by disease or auditory deprivation" (p.580). Interestingly, Skoe and Kraus (2014) stated that the fundamental principles of auditory reserve could be applied to other sensory modalities. In line with this idea, our proposal consists of using the term SR to describe the adaptability of sensory processes that help to explain the individual differences in the processing of sensory information when facing sensory-related disease or sensory deprivation. Moreover, the interaction between sensory impairment and CR was previously proposed (Lad et al., 2022). Specifically, SR interacts with CR, as well as with ER, influencing the adaptation to brain pathology. In this sense, SR integrates an active process that is supported by the following findings: (a) possible compensation for the decline in sensory acuity through the strengthening of multisensory integration with age (Misselhorn et al., 2020; Pinto et al., 2021); (b) possible role of early sensory stimulation in cognitive, affective, and psychosocial development (Schoentgen et al., 2020); and (c) positive effects of multisensory integration programs in general (O'Brien et al., 2020; Setti et al., 2014).

The term ER was probably first proposed by Oldenburg et al. (2018) in the area of neuropsychology as a "buffer against adverse subjective outcome and partly explain individual differences in outcome" (p. 2). More recently, ER was proposed as a domain of CR (Calderón-Rubio et al., 2022), but none of the above-mentioned works presented a comprehensive definition of this concept, even if Oldenburg et al. (2018) have suggested the following proxies for its measurement: personality traits, psychological resilience, and life circumstances, including mental health problems. Our proposal is to use the term ER to refer to the adaptability of the individual emotional functioning, which helps to explain individual differences in affective functioning, as well as in the processing of emotional information when facing emotionally challenging situations. Thus defined, ER is relevant to the adaptation to brain pathology. It is well known that throughout the lifespan we are exposed to stress whose impact on the brain, behavior, and cognition depends on the life cycle, the duration of the exposure, and the interaction between gene expression and prior exposure to adverse situations (i.e., epigenetics). In addition, chronic exposure to stress accelerates biological aging (Rentscher et al., 2020). ER is also supported by: (a) psychological resilience, which is associated with a more efficient connectivity between brain regions (Son et al., 2019); and (b) adaptive processes of emotional self-regulation, which is associated with a better prognosis in the recovery of neurocognitive sequels of brain injury (Stubberud, et al., 2020). The assessment of psychological resilience and emotional self-regulation only in the post-morbid phase has insuperable limitations. In this sense, the identification of potentially traumatic life events and premorbid neuropsychiatric history may reveal a lower ER (Oldenburg et al., 2018). Depression seems to be of particular interest given the higher risk of

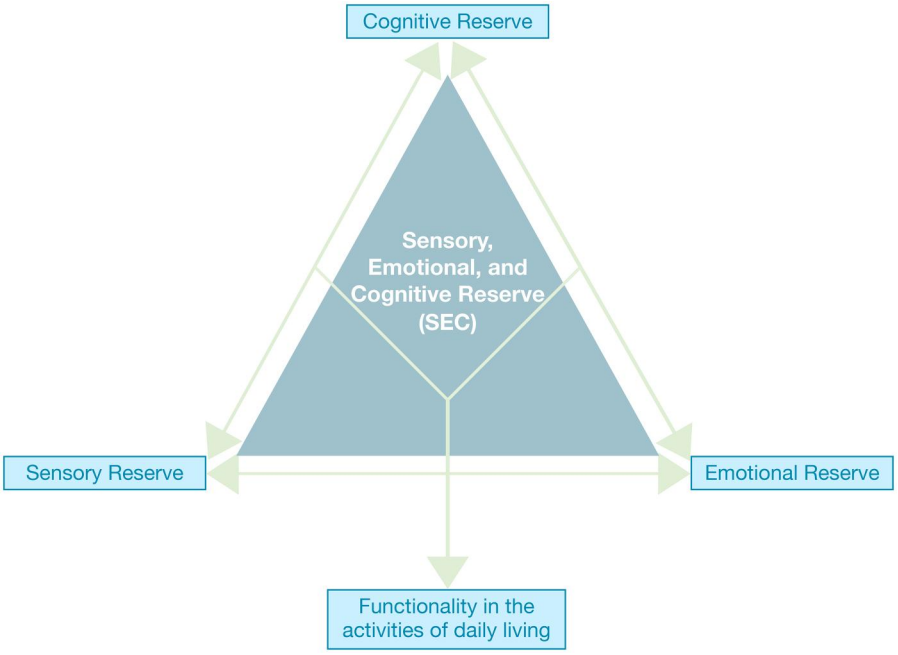

Figure 1. Schematic representation of the Sensory, Emotional, and Cognitive (SEC) reserve model.

developing neurocognitive deficits, which in turn can increase the risk of recurrence of depression (Perini et al., 2019). In addition, the inter-individual variability of psychological resilience and emotional self-regulation may make these measures particularly useful and sufficiently discriminatory in measuring ER.

The main contributions of this work are the proposal of the term SR and its definition for the first time in a neuropsychological framework, as well as a comprehensive definition of ER, framing these concepts in a SEC model that assumes their interdependence. It is worth mentioning that testing SEC reserve according to this model must consider its translation into measures of functionality in instrumental activities of daily living, since CR proxies such as leisure activity proved to be associated with the functionality in instrumental activities of daily living (Berezuk et al., 2021). We are developing a comprehensive tool for assessing SEC reserve according to the above-explained model and urge other researchers to join our efforts in this endeavor. Two other topics for future research are: (a) the clinical implications of this model; and (b) the influence of lifestyle factors (Song et al., 2022) on SEC reserve.

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