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Dual-Tasking and Multitasking

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DEFINITION: DUAL-TASKING

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Definition

Dual-tasking is the ability to perform two tasks simultaneously. Dual-tasking measures a component of executive function as participants are required to coordinate their attention to both tasks while they are being performed. Dual-tasking is differentiated from *serial multitasking* paradigms where individuals focus on and perform one task at a time, switching between those tasks. However, *concurrent multitasking* can be used synonymously with *dual-tasking* as the tasks are performed in parallel (e.g., talking on the phone while stirring a pan on the stove).

In dual-tasking, the difference between performance on each of the tasks performed individually and simultaneously provides an index of dual-tasking cost. To accurately assess dual-tasking, the chosen tasks should not tap the same input modalities or response mechanisms (e.g., manual versus oral responses). Additionally, the two tasks should involve different cognitive contents (e.g., visual tracking with a word or digit task) to ensure the tasks do not interfere with one another. The tasks administered during dual task assessment may include digit, word or pattern recall, various monitoring tasks (e.g., box crossing or E-checking), tracking a target or continuous choice reaction-time tasks. Real life behaviours such as walking and talking have also been used. To provide a dual-task measure of the ability to coordinate attention between the two tasks, single-task performance is often titrated or calibrated for each participant's own single-task ability. This can be done by assessing and administering the tasks at an individual's own span or single-task ability levels or statistically controlling for single-task performance.

Dual-tasking can be measured in terms of accuracy or response times with dual-task costs reflecting less accurate or slower performance when the two tasks are performed together compared to individually. Some studies consider dual task costs on the primary but not the secondary task while other studies consider any trade-off between the two tasks and assess overall dual task costs. Dual-task impairments are reported in Alzheimer's disease, where performance declines with disease progression, but deficits have also been found in Parkinson's disease, vascular dementia and traumatic brain injury. However, dual-task impairments are not found in depression and less consistently in mild cognitive impairment and healthy aging, especially when the tasks are titrated for individual ability levels.

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DEFINITION: MULTITASKING

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Definition

Multitasking refers to the ability to coordinate the completion of several tasks to achieve an overall goal. In everyday life, some tasks can be carried out in parallel (e.g., cooking potatoes and vegetables on the stove while the chicken roasts in the oven) but other tasks cannot because the individual is required to use the same resource (e.g., oven) for the different tasks or the individual is physically unable to perform the different tasks at the same time. The demands of the tasks may compete with one another (e.g., water on the stove boils over as your toddler falls and the phone rings) leading to there being costs for the active choices made, depending on the priorities that are required. When the two or more tasks can be performed in parallel, this is referred to as *dual-tasking* or *concurrent multitasking*; while situations where only one task can be performed at a time and switching between the tasks is needed to maximise performance, this is referred to as *serial multitasking*. It is the definition of serial multitasking that will be considered here.

Task switching during multitasking is self-initiated as there are not salient prompts to indicate when to switch. However, there may be cues in the environment that draw an individual's attention to engage in another task such as the passage of time, the completion of a number of items in a task or completion of the task itself. Individuals might not complete one task before moving to another. The order the tasks are performed in, and the time spent on each task, are self-determined. In some instances, however, there may be a best possible order to complete the tasks and therefore multitasking can benefit from pre- or online

planning. Individuals may also benefit from the use of help from others, aids (e.g., phone apps) or reminders (e.g., alarms) when multitasking.

Typical examples of everyday multitasking include cooking a meal with different items that need to be prepared simultaneously or carrying out some errands. However, multitasking is required in other aspects of everyday life including many occupations. Multitasking is thought to draw upon a range of cognitive processes including planning, executing those plans, working memory, retrospective and prospective memory; it is not considered to simply rely on single, general-purpose attentional capacity. These cognitive processes act in partnership with one another to achieve complex cognitive goals.

An individual may perform poorly in terms of multitasking compared to other individuals despite having the same background cognitive skills, knowledge and experience. In clinical assessment, a dissociation can be found between performance on traditional frontal executive tests administered in clinical settings (e.g., verbal fluency, Stroop Test), which are structured and the way to perform the task is clear, and multitasking paradigms, which can have multiple goals, are less structured in nature, can be performed in different ways and are more comparable to the environments that are typically faced in the real world. Multitasking can be assessed using board games and computerised procedures such as those using virtual environments, which attempt to simulate real-life settings, and in naturalistic environments.

Multitasking paradigms may report accuracy as well as rule breaks, switch costs, inefficiencies in task performance, failing to attempt tasks or spending too much or too little time on one task within a limited time period. Lesions in distinct frontal subregions have been associated with different multitasking impairments (e.g., right dorsolateral prefrontal cortex – planning; left frontal pole - rule-breaking and task switching failures). Multitasking impairments have also been associated with nonfrontal lesions and cerebellar lesions, as have neurological conditions such as behavioural variant frontotemporal dementia, Parkinson's

disease, schizophrenia, and traumatic brain injury. Multitasking also tends to show cognitive aging effects.

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