A Computational Model of Mind Wandering with and without Intention

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Abstract:

Mind wandering is the common phenomenon of experiencing one's own thoughts drifting away from the here and now towards some other internal thoughts or feelings [1]. In the past 10 years the research on mind wandering has increased tremendously [2] and new theories regarding why and under which circumstances mind wandering should and should not occur have been developed. Mind wandering plays a central role in many psychology domains, not only in basic cognition research but also more applied fields such as educational psychology, where mind wandering tendencies have been repeatedly shown to be negatively associated with different types of academic achievements [3], or clinical psychology (e.g., children with attention deficit disorder [4]). However most investigations in the mind wandering area focus on self-reported mind wandering and such introspective self-reports about psychological states are known to be bias prone [5]. Therefore, there are also attempts to achieve objective markers of mind wandering, for instance physiological or neuro-psychological markers [6]. In the present research project, we choose a different route towards a better understanding of mind wandering phenomena, namely we intend to use a formal computational modeling approach to gain a better understanding of the cognitive mechanisms that underlie mind wandering behavior.

So far, only very few attempts have been made in order to formalize mind wandering theories in computational models [7, 8, 9]. These previous attempts relied on the Adaptive Control of Thought- Rational (ACT-R) and implemented mind wandering phenomena within already existing ACT-R attention frameworks. However, the work by these researchers did not exceed the stage of published conference proceedings yet. Nevertheless, from these first publications it becomes obvious that the ACT-R architecture is generally suitable for the implementation of mind wandering behavior.

In the project we propose here, we also intend to use the ACT-R cognitive architecture and to implement new functions within this architecture that will be reflective of mind wandering. In doing so, we hope to gain a better understanding of how mind wandering occurs and how it may be represented in situations where it has detrimental effects on task performance.

One of the principal investigators, Nadia Said, already developed several models within ACT-R which have been published [10, 11] and presented at workshops[1] as well as (international) conferences[2].

The present project will feature advanced **mathematical modeling, simulation, and optimization (MSO)** approaches in a collaboration between researchers from the Department of Psychology and the **Interdisciplinary Center for Scientific Computing (IWR)** at Heidelberg University. Nadia Said, who is a doctoral student at the Department of Psychology, collaborated with the researchers at the IWR on her previous ACT-R projects and this collaboration has been proven to be very fruitful for both sides.

The aim of the proposed project is to integrate the psychological construct “mind wandering” into an established cognitive architecture that already covers a wide range of cognitive parameters (e.g. working-memory capacity, memory-retrieval,

[1] Workshops: "Formal Models of (Dis)Ordered Cognition" (FOMOCOG 14), "Scientific Computing in the Behavioral Sciences" (SCBS 2015)

[2] European Mathematical Psychology Group Meeting (2014), International Conference on Cognitive Modeling (2015), Tagung experimentell arbeitender Psychologen (2016), MathPsych/ICCM (2017)

decay) and psychological processes[3] (i.a. language processing, perception and attention, problem solving, decision making). This allows us to test novel predictions about the relationship between mind wandering and other psychological processes such as sustained attention, long-term memory retrieval (tau), and memory decay (d) in a formalized manner. The application of mathematical modeling, simulation, and optimization approaches will allow us to identify predictors of mind wandering within the ACT-R framework and make more precise estimates of cognitive abilities. In general this means moving from a descriptive view of the mind wandering phenomenon as a whole (e.g., correlations with working memory) towards a formalized testing of more fine-grained hypothesis (e.g., interplay between mind wandering and other ability parameters, like working-memory capacity but also others, and their relation to an outcome, e.g. task performance).

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