**Mind-Wandering and the Computational Theory of Mind: A Lofi-Hip Hop Perspective**

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**Abstract**

Computational Theory of Mind (CTM), which asserts that the cognition essentially operates as a computer does and that the mind is a Turing Machine that engages in symbol manipulation within the bounds of a formal system. CTM remains one of the most popular cognitive models, despite compelling evidence that it does not fully capture how human minds work. In this paper, I will aim to create further claims against the CTM through exploring the pervasiveness and properties of the phenomenon of mind-wandering. Mind-wandering is defined as the goal-specific and unintentional loss of mental autonomy. I will present a brief summary of the results of current research on mind-wandering, and explore the role the background music (specifically, lofi hip-hop) plays in inhibiting it when subjects are trying to limit mind-wandering during mentally strenuous primary tasks. I will then explore why these properties of mind-wandering present problems for CTM, and pose that they present better evidence towards an embodied view of cognition rather than a computationalist approach.

**Introduction: The Computational Theory of Mind**

For a majority of the last century, the Computational Theory of Mind (CTM) has been the mainstream theory of cognition. It states that the mind may be viewed as an information-processing system operating on formal symbols, and that simulation of a given mental state is sufficient for its presence; thus, the mind is a symbol manipulator that follows step by step functions to compute input and form output (i.e., a Turing Machine). It is not to be conflated with the computer metaphor, which equates the brain to hardware and the mind or consciousness to its software.

CTM is seen as a family of ever-expanding views. Although there are many variations of CTM, the one we will be focusing on for this paper is Classical CTM (CCTM), which states the mind is a computational system similar to a Turing machine, and core mental processes (e.g., reasoning, decision-making, and problem solving) are comparable to the computations that occur in such machines. The classical theory developed out theories of digital computation, which includes processes that follow ordinary algorithms and effective procedures, as well as many types of connectionist processes. (Piccininia & Scarantino, 2010) CCTM assumes that computation manipulates symbols in virtue of their formal syntactic properties rather than their semantic properties.

Classical CTM has attracted its fair share of criticism including insufficiency objections (based on alleged differences between computations and cognitive processes) and objections from neural realization, based on alleged differences between computations and neural processes. (Piccinini & Bahar, Neural Computation and the Computational Theory of Cognition, 2013) Most notably, the theory was criticized by John Searle in his Chinese Room Experiment, which argues that that a digital computer executing a program cannot be shown to have a mind or consciousness, regardless of how intelligently the program may make the computer behave; that is, there is no way to tell the machine is literally understanding what it is executing or if it is only simulating the ability to understand what it is executing. (Searle, 1980)

Searle’s argument against CCTM involves a basic claim about intentionality. No matter the elaborateness of the computer script, or whether we allow for the possibility that a sentient being inhabit and thereby control a physical embodiment of a computer program, the formal system itself never possesses an innate intentionality. The creator of such a machine has a demonstrable intentionality, but intentionality is not carried over into the program with respect to the program’s causal powers nor with respect to the “content” of the computational states induced by the program. (Rhodes, 2011).

More recently, growing criticism is directed at CTM for placing only the brain as the central, exclusive mechanism of cognition, thus forcing us to conceive of brain function in terms that ignore the dynamical relations among brain, body and environment. The embodied cognition theory argues that the best explanation of brain function may be found in the mixed vocabularies of situated cognition, developmental psychology, ecological psychology, dynamic systems theory, applied linguistics, the theory of affordances and material engagement, rather than the narrow vocabulary of computational neuroscience (Gallagher, 2018). Additionally, CTM does not take into account or explain the brain functions that do not align with the computational model, and are yet extremely pervasive and present in all humans: mind-wandering is one such phenomenon.

**Mind-Wandering and Music**

Cognitive neuroscience has reached a consensus that the brain is not idle at rest. (Kama, Irving, Millse, Patel, Gopnik, & Knight, 2021) We move from thought to thought unprompted, and our thoughts freely wander between topics. Often, we deliberately constrain our thoughts and work diligently toward a goal; in a quiet moment, you might suddenly start to ponder on what to order in for dinner. This phenomenon of spontaneously focusing attention on an unrelated, internally triggered thought is known as mind-wandering. (Smallwood & Schooler, 2006)

Mind-wandering can be described as a “graded loss” of mental autonomy and epistemic self control. It is also defined as “task unrelated” (it occurs despite the type of task we are engaging in and has little to do with any external stimuli or distractions). We can think of mind wandering as lying distinctly between dreaming and day-dreaming in terms of mental constraints applied to both its frequency and ease of occurrence, and its content. (Christoff, Irving, Fox, Spreng, & Andrews-Hanna, 2016).

There is also a further distinction to be made between “tuning out” and “zoning out”- when readers *tune out*, they can become aware that they are mind-wandering and, while they are doing it, might be able to control their train of thought at least to some degree. By contrast, in cases of *zoning out*, readers are assumed to be unaware that they are mind-wandering. Nevertheless, they will recognize that they were mind-wandering when they come to the end of the mind-wandering episode. (Fabry & Kukkonen, 2019). In either case, mind-wandering is generally perceived to be undesirable as it distracts us from the mentally strenuous, more salient primary task.

Listening to music while working on such a primary task is a common way of, at least marginally, inhibiting mind-wandering. There is a rich history of human beings inventing rhymes, melodies and folk songs while working on physically laborious tasks to make the task seem easier- effectively, encouraging mind-wandering to distract from the difficult of the task at hand (Kumar & Wajidi, 2016) However, the cognitive processes associated with active listening (where listeners participate in the music through vocals or instrumentation) are not relevant to the effect of passive listening. For the purposes of this paper, I will refer only to passive listening, in which workers listen to music that is not exclusively related to their tasks, and serves to inhibit mind-wandering instead of encourage it.

The computational model of mind-wandering posits that the phenomenon begins when one is not engaged in goal-oriented cognition (either between tasks or when in the middle of a task but not actively thinking about one’s goal). At such times, the model thinks about other, highly-activated thoughts in memory. (Hiatt & Trafton, 2015) Mind-wandering has been associated with beneficial processes such as goal-directed thinking, planning, and creativity. But, it also correlates with costly outcomes such as attenuated processing of the environment, driving accidents and disruptions to learning. (Seli, et al., 2018) A broader theme that has also emerged is that ‘mind-wandering’ encompasses a range of experiences that vary in terms of content, intentionality, task-relatedness, and relationship to external stimuli (among other things). This heterogeneity suggests that mind-wandering is best considered from a family-resemblances perspective; that is, as a heterogeneous, fuzzy-boundaried construct that coheres amid patterns of overlapping and non-overlapping features. (Seli, et al., 2018)

Mind-wandering is also influenced by individual traits, particularly by neuroticism; Neurotic individuals tended to report more mind-wandering during cognitive tasks, lower working memory capacity, and poorer attention control (Robinson & Gath, 2016), thus establishing a direct link between mind wandering and an individual’s self-perception and mood while performing a task. Mind-wandering’s dependence on an individuals’ ever-evolving internal mental state may explain why certain types of music are better than others at influencing and inhibiting mind-wandering during a mentally rigorous task.

**Why Lofi: The role of music as an inhibitor to mind wandering**

Lofi hip-hop has become increasingly popular as “productivity” music. Listeners believe that it helps them stay focused on tasks (especially those that do not involve active learning and recall, but during more passive instances of learning or focused tasks, such as researching an essay topic). There are several reasons for lofi music’s effectiveness at fostering productivity in listeners; the genre’s quirks and aesthetic all contribute to its appeal for the job.

The genre is known for heavily sampling from older popular music, invoking a feeling of familiarity within all of its tracks. Its approach to nostalgia is warm, relaxing, and, ultimately, a cocoon of sound which does not demand unease from its listeners.” (Winston & Saywood, 2019) This “ease of listening” property may be what contributes to the genre’s effectiveness as productivity music. Masataka and Perlovsky demonstrated that consonant music (typically associated with sweetness, pleasantness, and acceptability) helps “everyday” decision-making in the presence of cognitive interfering evidence, whereas dissonant music increases interference effects (Masataka & Perlovsky, 2013); lofi-music is perhaps the most consonant of mainstream instrumental music, which contributes to its facilitation of productivity in listeners.

Its commitment to the nostalgic and overall familiarity to other popular music is part of the genre’s unique aesthetic, and perhaps its success as accompaniment music to difficult, cognition-heavy tasks. Listeners report that they are less likely to get distracted, or engage in unconscious mind wandering if they use lofi hip-hop as background music while studying.

“…when listening to sad vs. happy music, people withdraw their attention inwards and engage in spontaneous, self-referential cognitive processes. Importantly, our results also underscore that DMN activity [closely associated with mind-wandering] can be modulated as a function of sad and happy music.” (Taruffi, Pehrs, Skouras, & Koelsch, 2017)

If our active task is not mentally stimulating enough, having background music to focus on will inhibit mind wandering. Music is a pervasive tool for dampening cognitive inhibitors to working memory processes, thus allowing listeners to focus more effectively on their primary task:

“Theories of mind wandering (perceptual decoupling, executive failure hypothesis, current concerns hypothesis, resource control argument) despite their diverse outlooks on the phenomenon, come to a similar conclusion is a result of limited cognitive resources and can explain why it interferes with task performance. We cannot selectively attend to all important stimuli, so our cognitive system must have some mechanism for optimally allocating resources—a posited function of the executive control system.” (Pachai, Acai, LoGiudice, & Kim, 2016)

Mind-wandering is reduced if a task is sufficiently difficult or engaging points us to a reason for why people prefer to listen to lofi-music when they are working; it fills in the gaps of activity that occur in the brain while focusing on a difficult task. As soon as we “get into the rhythm” of a task, the chances of being distracted by internal thoughts increases. Lofi-music is particularly good at occupying just enough of a cognitive load to inhibit mind wandering during a more difficult primary task (such as writing this essay!).

There is conflicting evidence on the effectiveness of background music in improving focus and attention; however, we can point to two recent studies that offer some positive feedback on the issue. The ‘arousal and mood hypothesis’ attempts to explain the effects produced by music, claiming that music enhances the level of arousal and mood, consequently affecting and benefitting the attentional process. The theory claims that adding a preferred auditory background makes the learning task increasingly interesting, thereby, enhancing the learner’s levels of arousal, which further leads to an increase in the level of attention, positively affecting the working memory. This results in more material being processed by the learner and consecutively enhances their performance. (Mohan & Thomas, 2020)

Listening to preferred music alleviates symptoms of fatigue, which is known to inhibit cognitive processing. This results in a brief periods (micro lapses) characterized by a lack of goal oriented processing. Hiatt and Trafton’s model predicted that, during these micro lapses, as with during low demand tasks that do not require much task-oriented thought, mind wandering has many more opportunities to occur.” (Hiatt & Trafton, 2015)

I chose lofi hip-hop as a primary focus in this paper (compared to other popular genres for productivity such as classical music) because its specific ability to enhance mood (through invoking comforting familiarity through its nostalgic outlook), and its ability to suppress mind-wandering will contribute to my claim in this paper: the quirks associated with mind wandering present serious philosophical problems for the computational theory of mind, and instead offers further support for the embodied embedded cognition theory.

**Philosophical problems presented by mind-wandering**

In their seminal paper The Restless Mind, [Smallwood and Schooler](https://www.frontiersin.org/articles/10.3389/fpsyg.2013.00373/full#B42), argue that mind-wandering often occurs in the absence of explicit intention but is still classified as a goal-oriented process and can thus be engaged without explicit awareness; thus, mind wandering can be seen as a goal-driven process, albeit one that is not directed toward the primary task:

“Assuming that individuals have a hierarchy of goals, it is possible that mind wandering leads to a shift of attention away from the primary task because an alternative goal becomes activated in the absence of attention. A crucial difference between mind wandering and standard notions of controlled processing, therefore, is that mind wandering reflects controlled processing that is automatically initiated by a personally relevant goal” (Smallwood & Schooler, 2006)

Smallwood and Schooler’s claim that mind-wandering is goal-oriented, and yet occurs without intention presents problems for the CCTM. The CCTM does not account for mental processes that behave so contrarily; if all mental processes are to be thought of as symbol manipulation within a formal system, then mind-wandering poses problems for such a definition because it does not contribute to the primary task we are engaging in, and indeed distracts from it. Goal-orientation implies that mind-wandering has some deep relevance to our cognition as a whole; the CCTM does not have room for such a phenomenon, as it assumes all mental processes to be equitable to functions that can be performed by a Turing machine.

Searle’s Chinese Room Experiment criticizes CCTM for lacking an explanation to the intentionality problem; we have no way of discerning whether a machine knows what it is doing. In cases of mind-wandering, while the process itself is unintentional, the fact that it is goal-oriented means that we usually know that we are mind-wandering, even if we do not want to be. This posits mind-wandering as a phenomenon that embodies Searle’s argument for intentionality, and forces us to ask if a machine (which necessarily follows our current view of cognition as computation) would be able to mind-wander at all. Even if intentionality is programmed within the machine, it seems implausible to explain why and how the machine would start to mind-wander in the way we do: without intention, but still directed towards some unrelated goal.

The type of mind-wandering that occurs during a subject’s focus on a mentally rigorous primary task can be inhibited by certain types of music. In this paper, I have highlighted the particular effectiveness of lofi hip-hop music at accomplishing this task; to summarize, music occupies the lapses in attention that occur during focus on a primary task, and thus inhibits mind-wandering by simply not giving the mind an opportunity to drift off. Lofi hip-hop’s unique quirks (highlighted in the relevant section) are what make the genre particularly suited to its role as an inhibitor. The music is acting here as not something that directly attacks the mental process itself, but rather evokes a physical reaction that inhibits mind-wandering. This brings us to the greatest contender to the CCTM: Embodied Cognition.

**Support for Embodied Cognition**

Embodied Cognition contends that our cognition is influenced and perhaps determined by our experiences in the physical world. Mind-wandering is shown, in the previous section, to be affected heavily by individual personality traits and the subject’s mood; this echoes the principles of Embodied Cognition. Lofi music is successful in suppressing this unintentional, non-conscious metal activity because it works to inhibit feelings of stress and improves the mood of the listener, thus reducing the chances of them drifting off while engaged in a difficult primary task. Smallwood and Schooler’s definition of mind-wandering as goal-oriented, and yet so easily influenced by the listener’s mood creates problems for the CCTM. CCTM treats mental activity as static symbol manipulation detached from the embedding environment, and neglects the ways in which the environment shapes mental activity. (Chemero, 2009)

Embodied cognition stresses the intertwined nature of thinking and acting, and as such is an antidote to the traditional divide between cognition and perception. While CCTM placed perception as only the “input” delivered to the computing mind, Embodied Cognition stresses that perception and action are directly relevant for our thinking, and that it is a mistake to regard them as separate. This adds to the already mounting empirical evidence shows that bodily states and modality‐specific systems for perception and action underlie information processing, and that embodiment contributes to various aspects and effects of mental phenomena. (Foglia & Wilson, 2013).

The fact that mind-wandering (even if it is perceived as an executive function itself, albeit one that occurs non-intentionally) is so heavily influenced by mood and internal states (that are decidedly affected by bodily functions and physical states) means that cognition can never be truly perceived through a computationalist lens. In the case of lofi music, the nostalgia-factor of the genre invokes feelings of comfort and familiarity and its auditory aesthetics are entirely focused on creating a mellow, ambient sound; the music is, in other words, crafted to elicit a physical response of a body that is being comforted into complacency, and is thus able to fulfill its primary task more effectively. If a mental process as ever-present as mind-wandering can be so heavily influenced by the body and its environment, this once again raises questions of whether the CCTM can prove to be a satisfactory model of human cognition.

Given the numerous contradictions present within research done on mind-wandering, as well as how notoriously difficult it is to pinpoint exactly when we are mind-wandering without actively putting an end to the whole mental process, it is safe to assume that more empirical research needs to be done to understand the full significance of this phenomenon towards the field of cognitive science. However, it undeniably poses some philosophical tension towards the CCTM.

# Works Cited

Chemero. (2009). Radical Embodied Cognitive Science. *Review of General Psychology* . DOI:[10.1037/a0032923](http://dx.doi.org/10.1037/a0032923)

Christoff, K., Irving, Z. C., Fox, K. C., Spreng, R. N., & Andrews-Hanna, J. R. (2016). Mind-wandering as spontaneous thought: a dynamic framework. *Nature Reviews Neuroscience* *, 17*, 718-731.   
DOI: <https://doi.org/10.1038/nrn.2016.113>

Fabry, R. E., & Kukkonen, K. (2019). Reconsidering the Mind-Wandering Reader: Predictive Processing, Probability Designs, and Enculturation. *Frontiers in Psychology* , 2648.  
DOI: <https://doi.org/10.3389/fpsyg.2018.02648>

Foglia, L., & Wilson, R. A. (2013). Embodied Cognition. *WIREs Cognitive Science* *, 3* (4), 319-325.  
DOI:  <https://doi.org/10.1002/wcs.1226>

Gallagher, S. (2018). Decentering the brain: Embodied cognition and the critique of. *Faculty of Law, Humanities and the Arts - Papers* .

Hiatt, L. M., & Trafton, J. G. (2015). A Computational Model of Mind Wandering. *Cognitive Science* .

Kama, J. W., Irving, Z. C., Millse, C., Patel, S., Gopnik, A., & Knight, R. T. (2021). Distinct electrophysiological signatures of task-unrelated and dynamic thoughts. *Proceedings of the National Academy of Sciences* *, 118* (4).  
DOI: <https://doi.org/10.1073/pnas.2011796118>

Kumar, N., & Wajidi, M. (2016). The effect of listening to music on concentration and academic performance of the student: Cross-sectional study on medical undergraduate students. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* *, 7* (6), 1190-1195.

Masataka, N., & Perlovsky, L. (2013). Cognitive interference can be mitigated by consonant music and facilitated by dissonant music. *Sci. Rep , 3* (2028).

Mohan, A., & Thomas, E. (2020). Effect of background music and the cultural preference to music on adolescents’ task performance. *International Journal of Adolescence and Youth* *, 25* (1), 562-573. <https://doi.org/10.1080/02673843.2019.1689368>

Pachai, A. A., Acai, A., LoGiudice, A. B., & Kim, J. A. (2016). The Mind That Wanders: Challenges and Potential Benefits of Mind. *Scholarship of Teaching and Learning in Psychology* *, 2* (2), 134-146.  
DOI: <https://doi.org/10.1073/pnas.2011796118>

Piccinini, G., & Scarantino, A. (2010). Computation vs. information processing: why their difference matters to cognitive science. *Studies in History and Philosophy of Science Part A* *, 41* (3), 237-246.   
DOI: <https://doi.org/10.1016/j.shpsa.2010.07.012>

Rhodes, A. D. (2011). The Case Against Computational Theory of the Mind:. *Portland State University.*

Robinson, M. K., & Gath, K. (2016). The neurotic wandering mind: An individual differences investigation of neuroticism, mind-wandering, and executive control. *Quarterly Journal of Experimental Psychology* *, 70* (4), 1-39.  
DOI:[10.1080/17470218.2016.1145706](http://dx.doi.org/10.1080/17470218.2016.1145706)

Searle, J. (1980). Minds, Brains and Behavior. *The Behavioral and Brain Sciences* *, 3*.

Seli, P., Kane, M. J., Smallwood, J., Schacter, D. L., Maillet, D., W.Schooler, J., et al. (2018). Mind-Wandering as a Natural Kind: A Family-Resemblances View. *Trends in Cognitive Sciences* *, 22* (6), 479-490.   
DOI: <https://doi.org/10.1016/j.tics.2018.03.010>

Smallwood, J., & Schooler, J. W. (2006). The Restless Mind. *The Psychology Bulletin* *, 132* (6), 946-958.  
DOI::[10.1037/0033-2909.132.6.946](http://dx.doi.org/10.1037/0033-2909.132.6.946)

Taruffi, L., Pehrs, C., Skouras, S., & Koelsch, S. (2017). Effects of Sad and Happy Music on Mind-Wandering and the Default Mode Network. *Scientific Reports* *, 7* (1).   
DOI: [10.1038/s41598-017-14849-0](https://www.nature.com/articles/s41598-017-14849-0)

Willems, R. M., & Francken, J. C. (2012). Embodied cognition: taking the next step. *Frontiers in Psychology* .  
DOI:  <https://doi.org/10.3389/fpsyg.2012.00582>

Winston, E., & Saywood, L. (2019). Beats to Relax/Study To: Contradiction and Paradox in Lo-Fi Hip Hop. *IASPM Journal* *, 9* (2), 40-54.   
DOI: [10.5429/2079-3871(2019)v9i2.4en](http://dx.doi.org/10.5429/2079-3871(2019)v9i2.4en)