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The Ergonomics of Learning: A Proposed Update to Bloom's Taxonomy

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Abstract: Benjamin Bloom's *Taxonomy of Educational Objectives: The Classification of Educational Goals* (1956) has been established as the most widely known curriculum design and assessment tool in American education. However, despite its notoriety, this tool, like any other tool, is susceptible to obsolescence. The primary topic of this article is the further revision of Bloom's Taxonomy to realign the framework to modern models of education and psychology. The secondary topic, which will be explored through the context of the primary topic, is the development, maintenance, and retirement of theoretical perspectives. While this article attempts to present a source-supported argument for revising Bloom's Taxonomy to fit with the modern pedagogical, psychological, and philosophical perspectives of learning, it also seeks to examine the theorization process itself. Is renovating an old theory to fit new evidence more beneficial to research than wholesale theory replacement? Is wholesale theory replacement optimal, or do the specifics of the situation affect the restoration vs. replacement argument?

Keywords: *Bloom's Taxonomy, learning, system, assessment*

Introduction

In 1956, a team of academics, headed by Benjamin Bloom, published a handbook, entitled *Taxonomy of educational objectives: The classification of educational goals,* which would eventually become the standard for classification of educational objectives across the United States. According to Engelhart et al. (1956), their goal was to develop a standardized system of language for teachers and administrators to use in post-secondary education curriculum design, implementation, and assessment. The original taxonomy, based in the behaviorist paradigm of educational psychology, consisted of the following six categories of learning objectives: knowledge, comprehension, application, analysis, synthesis, and evaluation. These categories were modeled as a linear progression of learning such that students needed to adequately demonstrate the behavior of one category before moving onto another, i.e., students must first demonstrate a mastery of a sufficient base of memorized knowledge before they can advance to comprehension activities and then demonstrate comprehension mastery before advancing to application activities.

The system's success inspired a second team consisting of cognitive psychologists, curriculum theorists, instructional researchers, and testing and assessment specialists to update it in 2001. Anderson and Krathwohl (2001) redesigned the taxonomy to fit the cognitivist paradigm of psychology by conceptualizing the learning objective as divided between a cognitive process dimension and a

knowledge dimension. While the six cognitive process categories roughly remained aligned with the original categories, the category nouns were substituted with the following category verbs: remember (knowledge), understand (comprehension), apply (application), analyze (analysis), evaluate (evaluation), and create (synthesis). Additionally, each cognitive process was paired with the following four knowledge categories: factual, conceptual, procedural, and metacognitive. This arrangement formed a 6X4 grid that could be used for organizing lesson plans.

Over the twenty years between the taxonomy's 2001 revision and today, the theoretical trajectory has delved deeper into a more socially oriented paradigm of theories (Bruffee, 1984; Israel et al 1998; Wegner, 1999) that has further widened the audience to include non-education specialists as equitable participants in the education process. This shift in theory audience seems to warrant a shift in theorization, namely, its accessibility and relevance to the general public. While both versions of Bloom's Taxonomy have provided educators a valuable tool for improving their ability to facilitate learning, this tool was developed specifically for use by professionals within the field of education.

Another reason for redesigning the tool is its misalignment with the current understanding of cognitive psychology. The 2001 version of the taxonomy has been in circulation long enough to garner its own fair share of criticism. Attempts to respond to some of its shortcomings could result in either an acceptable refinement or provide a starting point for new theories. Irvine (2017) details what he thinks is the most prominent of these shortcomings in his comparison of the Revised Bloom's Taxonomy (RBT) and Marazano's New Taxonomy of Learning (MNT). Both RBT and MNT were designed as linear theories of learning. Current research (Davis 1996; Davis, Sumara, & Luce-Kapler, 2008) suggests that learning is a non-linear process, and therefore, the linear design of RBT and MNT does not adequately reflect the current conceptualization of cognition. Redesigning the taxonomy into a non-linear accessible tool that coheres with the current understanding of learning seems prudent for perpetuating its usefulness into this new frontier of pedagogy.

Raising the question of a tool's relevance creates an additional set of questions regarding the reasons for its preservation. Is reconfiguring a theory to conform to modern evidence and sensibilities a better course of action than simply replacing it with a brand new one, or has the theoretical landscape changed so much that its replacement is the only appropriate option? Both choices offer a set of advantages and disadvantages which, of course, need to be weighed within the context of the decision. While the argument presented in this article cannot specifically answer the question of whether or not Bloom's Taxonomy should continue to be used or ought to be retired, it acknowledges that this question needs to be taken into consideration.

Purpose

The primary purpose of this article is to present a redesigned version of Bloom's Taxonomy intended for all participants in the learning process that also adequately reflects the non-linear nature of learning while still remaining somewhat consistent with the previous taxonomy versions. The secondary purpose is to consider of the limits of reconceptualizing an older theory to fit in a new context. These two goals can be best organized into the following research questions:

1. What design changes to the revised Bloom's Taxonomy are necessary to develop a tool that can accurately and accessibly reflect the complex nature of learning?
2. Can Bloom's Taxonomy be changed enough to meet these goals without sacrificing its core nature, or should it be replaced by an entirely new theory?

The conversation between assessment and learning offers a possible point of commonality between educators and students that could facilitate a more equitable power dynamic within the assessment and learning process. By introducing a framework that is meant to be used ubiquitously by all parties, conversations between participants that originate from this shared, familiar foundation could yield more productive outcomes. Another reason why this article contributes to the conversation is that it addresses a misalignment between a widely used theory and the phenomenon it is meant to model.

Modelling a non-linear phenomenon using a linear model could result in inconsistent or inaccurate conclusions, much like using a poorly calibrated thermometer for measuring temperature.
The conversation's meta-topic of theorization is also an issue that ought to merit a degree of acknowledgement if not outright exploration. Irving (2017) briefly comments on the proliferation of learning taxonomies. He mentions that Anderson and Krathwohl, while engaged in the process of revising the taxonomy for the first time, incorporated elements of 19 other taxonomies. To clarify, the meta-topic being acknowledged in this article is not the proliferation of theories about a phenomenon, but rather, the proliferation of similar theories that focus on the same facet of said phenomenon.

Although Bloom's Taxonomy may not have been the first attempt at modeling the psychological processes involved in an education context (Thorndike, 1911), its sustained popularity seems to suggest that the theory has managed to reasonably do so, which raises the question of why researchers needed to generate 19 other taxonomies that perform the same function. Does the education community truly need 19 different taxonomies to adequately conceptualize learning objectives, or is theoretical hypercreativity undoing meaningful progress towards understanding? And on the other side of the argument, if the core elements and structure of a popular theory, like Bloom's Taxonomy, are irreconcilable with the wider theoretical landscape, should its sustained popularity prevent a more relevant theory from taking its place?

Method

Since Bloom's Taxonomy operates on cognitive processes, the model ought to conform to the current idea of cognition. To establish a broad, but comprehensive contemporary concept of cognition to use as a scaffold for this redesign process, a modified version of this integrative literature review by Lubbe et. al, (2020) was implemented prior to the redesign. The resulting conceptualization generated from that review will be used in the discussion section to inform the redesign process and explain the limitations of this article. The following is an account of the review process.

Research Question

To initiate the research process, the research question "What are the most current psychological theories of cognition?" was entered into Chat GPT to generate a list of the most current psychological theories of cognition which were then recoded and used as starting points for the sampling process.

When offered the prompt "What are the most current psychological theories of cognition?", the response identified ten main theories of cognition: embodied cognition, predictive coding and Bayesian brain, connectionism and neural networks, dual-process theories, theories of cognitive load, cognitive control and executive functions, cognitive neuroscience of memory, social and cultural cognition, integrated information theory, and dynamic systems theory (OpenAI, 2025), see Table 1. This list of theories was then used to conduct a preliminary search for sources during the sampling phase.

Table 1.

Chat GPT Transcript (OpenAI, 2025)

Prompt - "What are the most current psychological theories of cognition?"
ChatGPT Response - Psychological theories of cognition have evolved significantly in recent years, incorporating findings from various disciplines, such as neuroscience, artificial intelligence, and evolutionary psychology. As of 2023, some of the most current and influential theories of cognition include:

Theory & Core Idea	Key Influences	Recent Developments
Embodied Cognition: Cognitive processes are deeply rooted in the body's interactions with the environment. This theory posits that our thoughts, perceptions, and knowledge are shaped by our bodily experiences, and cognition cannot be fully understood without considering the body's role.	Neuroscience, philosophy, and developmental psychology	Research continues to explore how sensory and motor processes contribute to higher-level cognition. For example, the idea that motor activities (like gestures or facial expressions) influence problem-solving and memory is gaining traction.
Predictive Coding and Bayesian Brain: The brain continuously generates predictions about sensory input and adjusts those predictions based on incoming data. This theory suggests that cognition is largely about minimizing prediction errors—discrepancies between expectations and reality.	Neuroscience, computational modeling, and artificial intelligence.	This theory is supported by neuroimaging studies and advances in machine learning, where brain regions are shown to operate based on a probabilistic framework, constantly updating beliefs based on experience.
Connectionism and Neutral Networks: Cognitive processes are seen as the product of networks of simple processing units (akin to neurons). Rather than focusing on abstract symbols or rules, connectionist models focus on patterns of activation within neural networks.	Artificial intelligence, cognitive neuroscience, and neuropsychology	The rise of deep learning models has paralleled the development of connectionist ideas. These models now inform theories of language processing, perception, and decision-making, offering insights into how memory and learning occur through distributed networks of neurons.
Dual-Process Theories: Cognitive processes involve two distinct systems: one that is fast, automatic, and unconscious (System 1) and another that is slower, more deliberate, and conscious (System 2). This theory is often applied to reasoning, judgment, and decision-making.	Cognitive psychology, behavioral economics, and decision theory.	Recent work has focused on understanding how these two systems interact, especially in complex or ambiguous situations, and how they influence behavior in contexts like moral decision-making, risk assessment, and biases.

Theories of Cognitive Load: Human cognition has a limited capacity for processing information. Cognitive load theory posits that when the demand on cognitive resources exceeds this capacity, performance and learning are impaired.	Educational psychology, cognitive science.	Researchers are refining how cognitive load can be managed in educational and learning contexts, exploring factors like intrinsic, extraneous, and germane cognitive load. Cognitive load theory is often applied to instructional design, multimedia learning, and e-learning environments.
Cognitive Control and Executive Functions: Cognitive control refers to the ability to manage thoughts, emotions, and actions in a way that facilitates goal-directed behavior. This theory focuses on how individuals regulate attention, inhibit impulses, plan, and switch between tasks.	Developmental psychology, neuroscience, and clinical psychology.	Researchers are investigating the neural mechanisms underlying executive functions, with a focus on the prefrontal cortex. There's also growing interest in how cognitive control interacts with emotion regulation and social cognition.
Cognitive Neurosciences of Memory: Memory is a dynamic system, influenced by both biological processes and cognitive strategies. This theory investigates how memories are encoded, stored, and retrieved, focusing on brain areas such as the hippocampus and prefrontal cortex.	Neuroscience, cognitive psychology.	There is increasing evidence from neuroimaging and electrophysiological studies about how different types of memory (e.g., episodic vs. procedural) are processed by distinct neural systems. Theories are also evolving around the concept of memory reconsolidation, where memories can be updated or altered during recall.
Social and Cultural Cognition: Cognition is not only an individual process but is deeply influenced by social and cultural contexts. This perspective emphasizes the role of social interactions, language, and culture in shaping cognitive development and thought.	Social psychology, cultural anthropology, and developmental psychology.	New approaches are focusing on how cognition varies across cultures, how social norms and expectations influence cognitive processes, and how group dynamics affect decision-making and problem-solving. Additionally, the role of digital environments (e.g., social media) in shaping cognition is becoming a key focus.
Integrated Information Theory (IIT): This theory, primarily associated with consciousness studies, posits that consciousness arises from the integration of information across different parts of the brain. The theory suggests that cognition and consciousness are deeply intertwined.	Neuroscience, philosophy of mind.	IIT has garnered significant attention for its potential to explain not just conscious experience but also complex cognitive phenomena like attention, perception, and self-awareness.
Dynamic Systems Theory: Cognition is seen as an emergent, dynamic process that unfolds over time, influenced by both internal states and external environments. This theory models cognition as a system of interacting components that evolve in non-linear ways.	Developmental psychology, systems theory, and neuroscience.	Researchers are applying dynamic systems approaches to understand developmental trajectories in children, the emergence of cognitive abilities, and even how mental states like attention and emotion interact with one another in real-time.
Trends in Cognitive Science and Future Directions		
Interdisciplinary Integration		Cognitive science is increasingly interdisciplinary, drawing from fields like AI, neuroscience, philosophy, and anthropology. For example, hybrid models combining elements of connectionism and symbolic processing (like neural-symbolic networks) are gaining popularity.
Neuroplasticity and Lifelong Learning		Advances in understanding neuroplasticity (the brain's ability to reorganize itself) are reshaping theories about cognition. Research now

	emphasizes that cognitive development is lifelong, challenging the older notion of a rigid developmental window.
Artificial Intelligence and Cognitive Modeling	AI and machine learning are providing powerful tools for modeling cognitive processes. This approach has expanded our understanding of topics like language acquisition, pattern recognition, and memory, and has implications for developing cognitive models based on real-world data.
Cognition in Artificial Agents	As AI systems (e.g., chatbots, robots) become more sophisticated, there's increasing interest in understanding how artificial agents can simulate human-like cognition. This includes work on AI models of learning, perception, decision-making, and social interaction.

These current theories represent a shift toward more holistic and integrative views of cognition, combining brain activity, bodily experiences, and social context in shaping how we think, perceive, and learn. Cognitive science is continuing to evolve, with research increasingly highlighting the interdependencies between brain, body, and environment in the production of cognitive processes.

Sampling and Appraisal

Based on the parameters of this question and the OpenAI response, a set of inclusion and exclusion criteria was derived to direct the data selection from the data collected, see Table 2. These criteria limited the search to broad theoretical overviews that discussed the general facets of each cognitive theory listed. Certain considerations were given to more program-level (context-specific) research sources depending on their contributions to the conversation on the larger theoretical perspectives. The search process took place across two main databases: Google Scholar and Semantic Scholar. The initial filtration process involved a survey of the source title and abstract. The first round of selected articles included in the review were then organized into categories based on the theory focus (i.e. all sources on embodied cognition were consolidated into the category 'Embodied Cognition'), see Appendix A. Each article was reviewed using an AMSTAR2 checklist (Shea et al., 2017) to determine source quality, and an itemized score was included with each review. According to Shea et al. (2017), AMSTAR2 was intended primarily for systematic reviews and meta-analysis of randomized control trials and non-randomized studies of interventions, which is why most of the articles were rated as low quality. A qualitative annotation, which included a brief summary of the article and the specific reason for source inclusion and exclusion, was also provided for transparency. The comprehensive account of the eligibility process including the AMSTAR 2 evaluation scoring and annotations was recorded and can be found in Appendix B.

Table 2.

Inclusion and Exclusion Criteria

Include	Exclude
• Mid-level to grand level theories involving cognition involved in the learning process • English language sources (Special consideration will be given to non-English articles translated into English.) • Sources written prior to 2001 (Special consideration will be given to some pre-2001 sources, depending on how they are cited in more modern sources. E.g. Is the 1999 model of phenomenon X still referred to in recent work as the current, most accurate model of said phenomenon?)	• Program-level theories that focus on a specific case and cannot be generalizable • Non-English language sources • Sources written prior to 2001 without adequate contemporary reference.

Synthesis

Upon completion of the sampling and appraisal process, a selection of the ideas (code phrase and accompanying quotation for context) was extracted from the included sources and cross-referenced from within the theoretical literature and across the literature of the other nine theories. The cross-referencing procedure used both 'word match' and 'theme match' content analysis, meaning that a reference was recorded only if the reference was either a word-for word match with the code phrase (i.e. cognitive control = cognitive control) and was mentioned in a similar context as the quotation or if the reference included at least a portion of the descriptive code and was mentioned in a similar context as the quotation. The resulting connections (or lack thereof) provided a rough guide to inform the design of the current model of cognition by indicating an idea's prevalence within the theoretical area and across the full spectrum of theoretical discussion of the field of cognitive science, and can be found in Appendix C. A visual representation of the cognitive model was developed and included in Figure 1.

Model Explanation

The results from the integrative literature review revealed three structural principles that needed to be accounted for in the construction of the current model of cognition. First, the model needed to account for externally focused cognition (e.g. concentrating on the task at hand), and internally focused cognition (e.g. thinking about a past vacation while at work). This scope requirement was mainly determined by the existence of 'on-line/off-line' conceptualization of cognition in the literature. Second, the model needed to account for multiple scopes of perspectives. Single facet theories (e.g., cognitive neuroscience of memory, integrated information theory) presented a narrow but detailed perspective on a single element of cognition, whereas other theories such as dual-process theory offered a more comprehensive account of the full spectrum of cognition (e.g., dual process theory, dynamic systems theory) as well as cognition within a context (e.g., social cognition theory). Finally, the model needed to account for the interconnectivity of theories due to cross theory references of the same idea. While some theories may exist in oppositional tension with others, to outright disregard one or multiple evidence-supported perspectives would have resulted in an incomplete

conceptualization of cognition. Therefore, rather than conceptualizing cognition from a singular perspective, the resultant model of cognition was designed as a meta-theoretical framework used to coordinate each theory within a single integrated plurality of perspectives.

Figure 1.

Integrative Plurality of Cognitive Theories

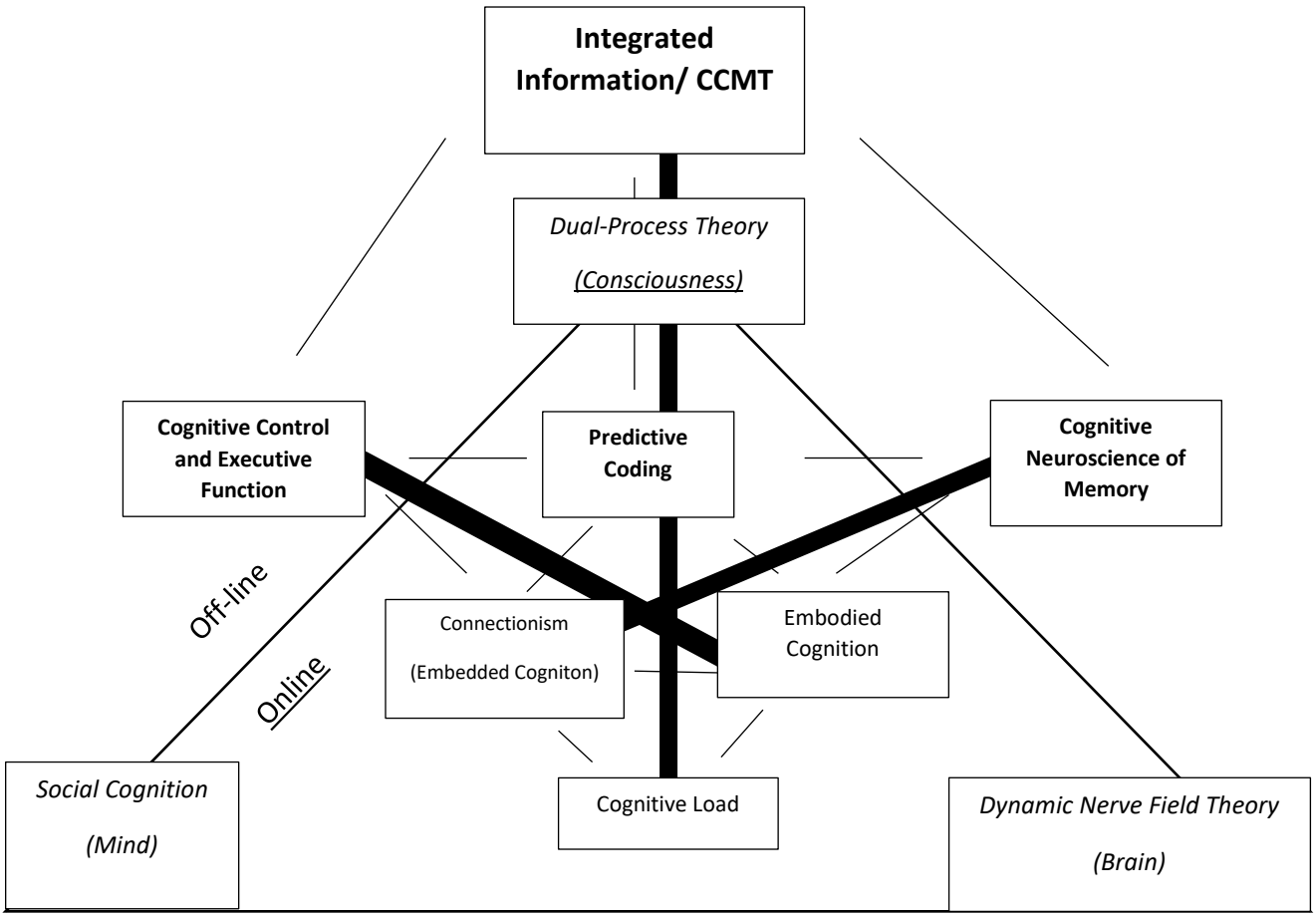


Figure Note: Thin Lines = Connections (Tension Elements), Thick Lines = Oppositions (Compression Elements)

The on-line/off-line concept provided the foundational foreground/background of the model in that it described the broadly accepted idea of engagement in an external, physical environment and detached abstract thinking (Wilson, 2002; Kasabov, 2015; Garzon, 2008). The second layer was built from the three 'system wide' theories or theories which describe the 'whole' of the plurality; these theories include social cognition theory, dual process theory, and dynamic systems theory. Social cognition's concept of *intentional action* (Tomasello et al., 2005), and dynamic systems theory's *antirepresentational interpretation* (Garzon, 2008), as well as dynamic systems theory's connection to

dynamic neural field (Samuelson et al., 2014) seem to place both of these theories squarely on the on-line side of the border, whereas dual –process's *system 2* (Evans and Stanovich, 2013) seems to indicate the off-line placement of this theory. Social cognition and dynamic systems theory have been placed on either corner of the model to reflect the distinction between the abstract, socially derived mind as and the concrete, neurologically-based brain. A more accurate conceptualization would be to envision these two theories as extremes on a spectrum, the center of which being roughly embedded vs. embodied knowledge (Pouw et al., 2014).

Finally, the remaining seven theories were organized into a network of interconnected nodes which spanned the off-line/on-line border. The arrangement of the theories was established using the following three considerations: a) off-line thought vs. on-line thought, b) relation to either social cognition or dynamic neural field, and c) the tensions and synergies of each field. To begin, cognitive load theory was placed the in Tier 1 between social cognition and dynamic systems theory; despite its focus on limiting neural load in working memory, its strategies for doing so involve manipulating the embedded knowledge of instructional materials to better align with how information is processed in the brain (Van Merriënboer & Sweller, 2010).

Connectivism and embodied cognition were situated above cognitive load theory in Tier 2 based on the on-line nature of each theory and their numerous overlaps established in the synthesis amongst all three theories (cognitive load, parallel distributed processing, emergence, etc.). Connectivism's theoretical position on knowledge as *embedded* in the connections between each unit, not the unit itself, as well as the requirement of active firing patterns for its retrieval (Maia & Cleeremans, 2005) seemed to fit more towards social cognition as it presents knowledge, learning, and consciousness as emergent abstractions generated from the collective output of a distributed array of simultaneously firing neural networks. Connections between connectionism and social cognition as well as a description of connectionism's counterpart in the off-line area of the model were established through the following passage of Adophs (2001) neurological explanation of social cognition:

> …are there systems in the human brain for processing specific social stimuli, such as faces [21], or are there only systems that carry out more domain-general processing, on which social and face processing may draw? It seems likely that both aspects have some truth to them: face-responsive regions in fusiform gyrus and superior temporal sulcus evolved as part of a distributed neural system for processing faces; however, this system does not care whether the stimuli are in fact faces, or are non-face stimuli that make similar computational demands (notably, that require expert subordinate-level categorization amongst visually similar stimuli). A recent integration of findings proposes that perception of invariant features of faces, such as identity, relies heavily on the fusiform gyrus, whereas perception of changeable aspects of faces, such as gaze and expression, relies more on regions in superior temporal sulcus. (pp. 232-233)

This distinction between general distributed networks and localized brain regions pointed to cognitive neuroscience of memory as the closest counterpart to connectionism because of the theoretical focus on neural structures in this branch of research; especially Tulving's (2002) work into episodic memory where he stated:

> …Memory systems are organized structures of more elementary operating components. An operating component of a system consists of a neural substrate and its behavioral or cognitive correlates. Some components are shared by all systems, others are shared only by some, and still others are unique to individual systems… (p.6).

Since recalling a memory does not require the attention to be engaged in the world (e.g. thinking about a past vacation while sitting at home), setting this theory as the counterpoint to connectionism seemed appropriate, especially considering the number of overlaps between predictive coding, embodied cognition, and dynamic neural field.

Embodied cognition's position in the model rests on three tenets: that the physical body plays an integral resource for directing cognition, that the direction of cognition is towards action, and that action takes place in a time-dependent environment (Wilson, 2002). This seemed to suggest that alignment tended more towards dynamic neural field (dynamic field theory [DFT]), since DFT, according to Samuelson et al. (2014), can be described as "…embodied, dynamic systems approach to cognitive-level processes based on an understanding of brain function at the level of neural population dynamics…" (p.193). Placing the abstract cognitive control and executive functions opposite concrete embodied cognition naturally followed, considering Anderson's (2003) observation regarding a principal criticism of embodied cognition. Despite the theory's ability to explain a host of context-dependent phenomenon, it falls short when confronted with off-line, abstract activities such as planning, generalizing strategies, and problem solving. Regarding these activities, Anderson (2003) states that," …Admittedly, they are all based on an underlying set of reliable control systems; but these control systems are not sufficient themselves to organize the *global* structure of the activity…" (p. 116).

Predictive coding's overlap with cognitive control theory, connectionism, embodied cognition (Pezzulo, 2013), cognitive neuroscience of memory, and integrated information theory/circular coordinated messaging theory warranted including it in Tier 3, along with cognitive control and executive function and cognitive neuroscience of memory. While it is still predominantly an on-line theory given that half of its function is to process bottom-up processed sensation, its function of error prediction also necessitates top-down set of predictions, indicating that at least, in part, interaction with an off-line planning theory (e.g., such as cognitive control, cognitive neuroscience of memory) seems unavoidable.

Integration information theory/circular coordinated messaging theory was placed on top in Tier 4 in the off-line area directly above predictive coding based on its connections with cognitive control and executive function theory and predictive coding. The physical substrate of the consciousness component of integrate information theory, as mentioned in Tononi et al. (2016), could offer a conceptual link to cognitive neuroscience of memory as it hinges on the idea that "…every experience exists intrinsically and is structured, specific, unitary and definite…" (p. 450), which mirrors the concept of localization of knowledge in brain regions. However, based on IIT's interconnections with the other theories, it might be better conceptualized as a broader theory than the others.

This tentative arrangement of theories was constructed using a very limited collection of literature which does not fully explain the full aspect of cognition but covers enough to present a relatively clearer view of cognition than the theories can provide on their own. Since the synthesis resulted in ill-

defined connections, meaning no indication of directionality, any connections mentioned were not intended to suggest a specific directionality, but merely overlapping ideas in the literature. Further investigation into the narratives generated between theories may have resulted in a more specific flow pattern. However, given the current evidence, any directionality interpreted into this model should be considered as speculative.

Discussion & Model Presentation

Using this meta-theoretical model of cognition from the integrative literary review as the framework, the following attempt was made to reconfigure Bloom's Taxonomy's cognitive process categories into a more dynamic, non-linear arrangement. The resultant model includes some directionality between the nodes to provide a means of consistent navigation through the different perspectives. However, considering the integrative literature review did not specify the nature of each connection (i.e. unidirectional, bi-directional), these choices should be interpreted as a source supported interpretation, not as hard fact. The resultant model configuration will also require the abandonment of categorizing cognitive processes in terms of higher or lower, due to the categories' interrelationship into a singular multicomponent cognitive process, as well as looser adherence to the definition of each cognitive process. For the sake of brevity, only the main cognitive process categories will be addressed; the treatment of the subcategories should be assumed as the same as the previous version. The new model will be presented piecemeal for clarity.

To begin, one must start with the external environment. Cognitive load theory's focus on managing input to optimize working memory seems to coincide well with the *Analyze* category, which, according to Airasian et al. (2001), is primarily directed towards the breaking down of complex concepts into manageable units. Aligning *Analyze* with cognitive load theory comes with a few implications. First, it redirects the cognitive process towards a more physical interpretation, meaning breaking down is more in line with actually breaking apart or differentiating the information source into smaller units of input for processing. Second, it suggests that *Analyze* occurs as an online, real-time process which is more in line with System 1 processes. These implications will be addressed towards the end of the model presentation.

Next, one must address Tier 2 alignment. Connectionism's view of knowledge as an emergent phenomenon from the collective parallel activation of a distributed set of neural networks seems to reflect the nature of the *Create* objective, as it focuses on the assembly of elements into a cohesive whole (Airasian, et al., 2001). Given that the definition does not specify novelty as a requirement, this process could be interpreted as a recombination of elements into a known whole (i.e. mentally reconstructing a perceived stimulus from fragmented sensory input) or combination of elements into a unique whole (i.e. improvising a tool from unrelated objects). Regardless of which creative process one engages in, the activation and coordination of the body will be necessary to actualize the concept back into the external, which leads to embodied cognition.

The category *Apply*, as described by Airasian, et al. (2001), fits well with this theory because its focus on carrying out either a known or unknown procedure in a situation and it involves incorporating the body and the environment into the process of cognition. This incorporation, of course, generates a

cognitive load within the system, which, according to Wilson (2002), can be offloaded on to the environment, thereby providing new information for reanalysis.

These three theory-category pairings provide the primary loop of cognition in the system. First, information is analyzed into smaller units. Then, the units are reassembled, either into the original concept or a novel concept during the create process. Finally, the concept is acted upon by the body through application, which produces a change in the external environment that must then be reanalyzed to continue the learning process. This iterative process loosely maps onto Kolb's (2015) experiential learning theory in that *Analyze* approximately links with reflective observation, *Create* links with abstract conceptualization, *Apply* links with active experimentation, and the product of the application links with concrete experience.

From here, one can begin to address Tier 3's cognitive neuroscience of memory, which coincides with the *Remembe*r objective in that the focus of the theory as well as the cognitive process is on information encoding and retrieval. By first analyzing the information in question, creating a concept from the analyzed components, and applying that concept within a situation, the learning processes align with the underlying biological mandate for cognition (i.e. organisms tend to retain knowledge that will improve their perception and performance in an environment; Wilson, 2002). This configuration also illustrates a means of connecting connectionism and cognitive neuroscience of memory through the following meta-narrative.

Adolphs (2001) observes that the fusiform gyrus and other specialized regions of the brain evolved from a distributed, non-specialized system. The existence of this larger system is corroborated by Maia & Cleeremans' (2005) investigations into the connectionist interpretation of consciousness. They argue that that individual networks within this distributed system, most of which contain recurrent connections, generate representations of knowledge when activated by neuronal firing. These knowledge representations then compete with each other across a larger global workspace before settling into a steady state of activation, or as they claim, conscious experience. Maia & Cleeremans (2005) further explain that this process of settling, also referred to as global constraint satisfaction, occurs in recurrent neural networks as a function of the network's input and the knowledge carrying connection weighs across the network. In other words, conscious experience arises from engaging with a situation.

Anderson (2003), in turn, supports Maia & Cleeremans's idea of global constraint satisfaction through the lens of embodied cognition. According to his overview of this perspective, cognition is constrained by the embodiment of the one engaged in the cognition, meaning our conscious thought is shaped to our body's function in the world. Wilson (2002) expands on this further by presenting a number of specific constraints. Cognition, as explained by embodied cognition, is constrained by the following: a) situation in a context, b) operation in real-time, c) load capacity (which is sometimes split between the brain and the environment), d) the parameters of an external environment, e) limitations of action in an environment, and f) 'on-line' default (i.e. even when individual's focus is not on a situation such as when recalling a long-term memory, their thought patterns are constrained by their experience of said memory).

At the neural level, these constraints are best explained through dynamic systems theory. Samuelson et al.'s (2014) account of the dynamic systems theory of psychology, also referred to as dynamic field theory, explains that neural fields are metrically organized in such a way that neurons that exist closer together respond to similar stimuli whereas neurons that exist farther apart respond to dissimilar stimuli. These fields are excited locally but inhibited laterally, and with each excitation/inhibition, they reliably fall in and out of attractor states much like local neural populations. These attractor states register as stable 'peaks' of activation, which results in the ability to identify or localize a stimulus to a specific neural field.

D'Esposito & Postle (2015) expand on activations of the neural fields by illustrating how these activations become short-term memories through state-based memory models. State-based memory models conceptualize short-term memory and long-term memory as operating in the same substrate of neural fields. When perceiving a piece of information, nodes in the long-term memory are activated to represent that information. When no longer directly perceiving it, the representations can be held in the brain through sustained activation via focus of attention. The three state-based models presented in the article differ on the capacity of this focus of attention, but they do agree that deactivation does not happen instantaneously. When the focus of attention no longer actively sustains a representation, the neural field gradually fades, thereby allowing the previously activated neural field to still interfere with other fields in the long-term memory.

Schacter & Addis (2007) develop on this notion of activation and reactivation of discrete neural fields through their research into constructive long-term memory. This model of memory posits that memory is not a reduplicative process in which an event is simply replayed in the mind, but rather the memory is reconstructed from representational components into a cohesive whole. In other words, recalling an 'item' from long-term memory means reactivating the network of neural fields used to construct the representation, and recalling an episode means reactivating the sequence of activations that occurred during its encoding. The reconstruction is not a perfect replication of the memory due to interference from closely related neural fields. These fields, when activated, distort the reconstructed memory. These distortions are especially prevalent in memories of similar situations or similar people due to the neural field overlap. Over time, these distortions eventually lead to consolidation through gist-based distortions in which the individual remembering an item reconstructs a generalized version of the item, not the detail specific item.

Binder and Desai (2011) further build on this notion of generalization through their work on semantic memory. The following statement seems to corroborate the constructive memory model:

> …Over the course of many similar experiences with entities from the same category, an idealized sensory or motor representation of the entity develops by generalization across unique exemplars, and reactivation or 'simulation' of these modality-specific representations forms the basis of concept retrieval…(p. 528)

Binder and Desai (2011) present the neurological evidence that supports this idea by claiming that there are portions of the human neocortex that exist between modal sensory-motor systems which operate as convergence zones for information. These convergence zones provide a neurological explanation for supramodal representations or abstraction, and so, drawing from this range of perspectives, this meta-narrative provides a link between the global perspective of connectionism and

the local perspective of cognitive neuroscience of memory via the constraints of embodiment and the dynamic behavior of neural fields.

Based on this notion of consolidation of modal-specific representations to supramodal representations, a possible connection could be drawn between the cognitive neuroscience of memory to integrated information theory. Tononi et al. (2016) mentions that "…the coexistence of functional specialization and integration in the cerebral cortex is ideally suited to integrating information…" (p. 458). Combining this statement on the cortex with the following central claim of integrated information theory from Tononi (2008), "…at the fundamental level, consciousness is integrated information, and that its quality is given by the informational relationships generated by a complex of elements…" (p. 217), an argument could be made for its alignment with the *Understand* objective, which is centered on construction of meaning from incoming messages (Airasian, et al., 2001).

An argument of alignment with *Understand* could also be made for a competing theory of consciousness: circular coordinated message theory. Cerullo (2015) posits a more dynamic explanatory framework because it defines consciousness as information circulation in feedback loops. This approach to consciousness is more directly supported by Maia and Cleereman's (2005) insight from the connectionist perspective on consciousness in that feedback loops or reentrant connections are necessary for achieving global constraint satisfaction. Despite their differences, both theories seem to implicate the corico-thalamic connections as necessary neural structures of consciousness (Tononi et al., 2016, p.452; Cerullo, 2015, p.5), which might suggest a strong connection to predictive coding.

Predictive coding theories, according to Shipp (2016), operate on the basic tenet that during perception, the brain generates a prediction or best guess model of the external world. This prediction is then compared against new sensory input which results in an error. The error is sent back through the model to update the brain's prediction. Shipp (2016) cites the lateral geniculate nucleus in the thalamus, which features a number of corticothalamic connections, as a model system for exploring this type of feedback. Aitchinson and Lengyel (2017) argue that generating perception using the prediction error between sensory input and a prediction is more energy efficient than sending the sensory input directly because transmitting the spikes directly is more costly from an energy standpoint. This comment on energy savings coincides with Binder and Desai's (2011) argument regarding familiar and novel stimuli, which could also tie into dual processing theory as an explanation for shifting between system 1 and 2, but given the lack of direct reference between predictive coding and dual process theory, this connection is highly speculative. The connection between predictive coding and *Evaluate*, however, is much more evident given that this cognitive process category's focus is on making judgements using criteria and standards (Airasian, et al., 2001). Additionally, its arrangement within the system becomes just as clear if one considers the prediction as the highly integrated model generated through the understand process, and the sensory input as the initial integration from the *Create* process.

Incorporating evaluate/predictive coding in the central position of the model introduces another loop in the system as well as an additional step in the first loop described. Based on the current configuration of the redesigned taxonomy, information must first be deconstructed and reconstructed via *Analyze* and *Create* objectives. This information is then further processed through *Evaluate* and

Apply objectives for error correction and contextualization respectively. Once processed, the information is encoded via *Remember* and consolidated into a model via *Understand.* This model will then be fed back into the cycle as the prediction or expectation of the *Evaluate* step in the next cycle.

Finally, to complete the system and address the analysis issue from the beginning, this model will need to include an additional category to account for the highly abstracted executive function mentioned in the literature of at least three previously covered theories (Maia and Cleereman, 2005; D'Esposito & Postle, 2015; Dove, 2011). This category will be similar in definition to *Understand* in that it will involve constructing meaning, but rather for *outgoing* messages as opposed to *incoming* messages. This new category, *Communicate*, will align with cognitive control and executive function theory by encapsulating the supervisory cognitive process informed by the abstracted model that directs attention, evokes inhibition, and modulates motor control during normal cognition. As an extension from the *Understand* category, *Communicate* will portray the additional top-down links with the *Create* objective to selectively inhibit analyzed components during the assembly process (which should address the implication of analysis as the primary cognitive process), and the *Evaluate* objective to monitor error correction. The addition of this element also introduces a means of aligning Bloom's Taxonomy with more socially oriented theories of learning in which learning takes place within a collaborative setting. A complete rendering of the system is included in Table 3 and Figure 2.

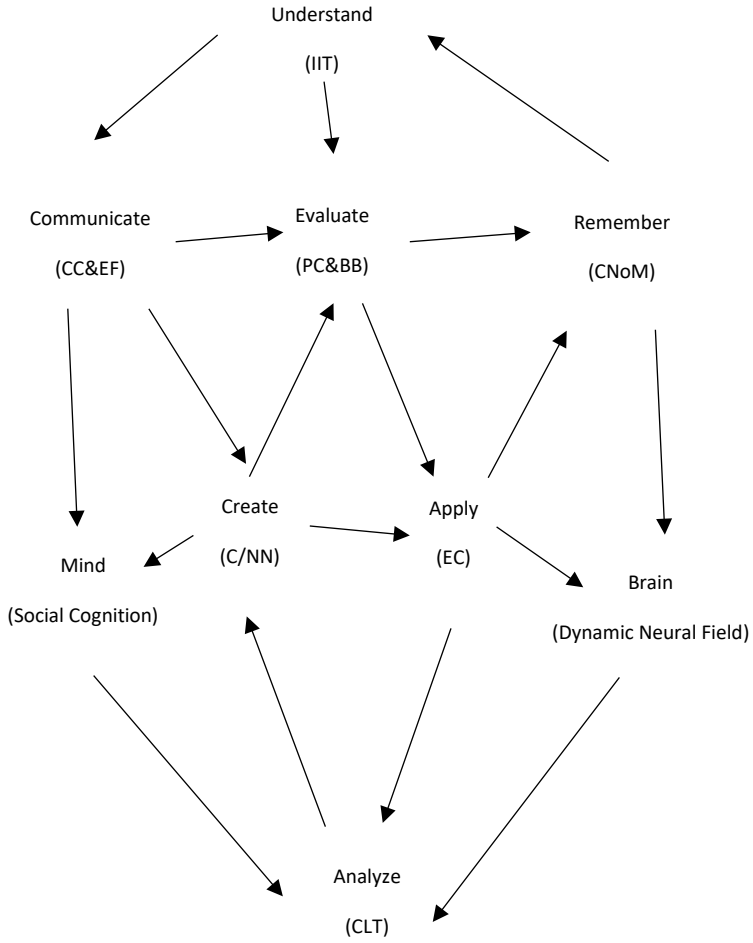
Table 3.

Model of Non-Linear Bloom's Taxonomy

Level	Description
Analyze-Create	Information to knowledge conversation via sensation
Create-Mind	Knowledge-information Conversion via Embedding
Create-Evaluate	Bottom Up Knowledge generated from external environment
Create-Apply	Global Constraint Satisfaction through interaction with knowledge.
Apply-Remember	Memory encoding based on embodied interaction
Remember-Understand	Knowledge Consolidation from Incoming messages
Understand-Communicate	Knowledge consolidation for outgoing messages (both to internal and external environments)
Understand-Evaluate	Top-Down Expectation
Communicate-Mind	Theory of Mind
Communicate-Create	Planning involved in information to knowledge conversion
Communicate-Evaluate	Monitoring
Evaluate-Remember	Error Correction
Evaluate-Apply	Working Memory
Apply-Brain	Online Load from Task
Remember Brain	Offline Load from Recall
Mind/Brain-Analyze	Online and Offline Load from brain determining information uptake from mind

Figure 2.

Model of Non-Linear Bloom's Taxonomy



Limitations and Practical Recommendations

Due to project constraints, the cross-referencing procedure was completed solely by the principal researcher, and therefore the results should be interpreted as more or less a source of informed conjecture. Another consideration is the interpretation of the Bloom's Taxonomy structure. Adopting this version of the taxonomy will require reconceptualizing the higher and lower cognition aspect of each process as well as their sequential nature; although this model was presented in sequence, the model in practice should be regarded as continuously operating. In other words, the full system is always working and never stops. Finally, this project involves using meta-theory which is a relatively new means of theorizing. It asks the reader to track holarchic relationships between different layers of theory and how they interact within an integrated yet pluralistic system. This method of thinking may prove to be quite challenging and therefore less useful to the practitioner, but for those practitioners willing to engage with the integrated pluralities associated with meta-theorization, the following is a

possible strategy for putting this meta-theory to work in the classroom. Again, this should be interpreted largely as conjecture.

Practically, this model can be conceptualized as an expertise tracker to help secondary students, post-secondary students, and teachers visualize the progress and structuring of collectively available raw external information into an integral architecture within the consciousness. While this model involves non-linear movement through a system of learning objectives, this non-linear movement should result in a meta-linear movement of learning. First, information from the external world is converted into internal knowledge (analyze – create, apply), accumulated and embodied knowledge converted into intelligence (create, apply – communicate, evaluate, remember), and finally intelligence is consolidated into intuition (communicate, evaluate, remember – understand). Expertise, in this sense, is about putting together the cognitive architecture for good instincts, and then efficiently communicating the method of doing so to others.

In terms of progression, the following steps provide an adjustable difficulty mechanism unique to each objective, however this strategy requires two system-wide considerations. First, novice level learners should operate in groups, but as their structured experience develops, they should steadily be weaned away from group activities. This weaning can be accomplished as per the individual needs of each student. Second, novices need to work from being students to becoming teachers in their own right. The idea is that as students build experience and structure it towards efficient decision making and dissemination via communication, the role of the teacher shifts from being a direct instructor to a facilitator to finally an evaluator. One final consideration is that this system should be implemented in a flipped classroom configuration where introduction to material takes place at home and problem solving or discussion took place during class time.

Going back to the model found in Figure 2, the first step is to analyze or break down collectively available raw information. The goal of this step is to help students the ability to grapple with the ever expanding universe of content at their disposal, either through the physical library or through the internet. At the beginning, a shallow information pool, such as a curated list of sources, is recommended. The student should work towards navigating larger pools such as the school library, public library, and finally the internet. A tangible means of assessing this step can be accomplished through an annotated quotation activity. Students are given a word or topic and asked to conduct a search for that topic within a set of sources. Students record verbatim quotes from each source and cite the origin of the quotes. This activity should be implemented as an ongoing list project to establish a raw content store for the next step.

The next step is to synthesize all of these ideas into a reintegrated whole, specifically a workable model of the topic in question derived from the quotations pulled from the previous assignment. Ultimately, the goal of this step is converting the broken up information into a primary integration of knowledge. The recommendation for this stage is to implement as either an ongoing journaling exercise, zettlekasten project, or mind map which explicitly demonstrates how each student arrived their final configuration of information and how these configurations complexify over time. Each component and/or connection should be tracible back to the quotation list through either an established citation practice or a custom labeling system. This stage should also occur predominantly outside of the

classroom as homework is examined periodically by the teacher at the end of each week but not graded.

The resulting model then needs to be applied to a problem. The goal of these problems is to provide the real-world constraints on knowledge so that it can produce useful results when applied to a cognitive load. In-class problem solving is recommended for this objective. Load should be adapted to fit the needs of the students or student. For novices, these problems need to have abstract, yet definite, solutions contained in singular disciplines, but as they become experts, the solutions become increasingly concrete and therefore more and more indefinite, requiring more transdisciplinary thought. This step should also include a brief session of direct instruction of a worked problems to help students understand what they did right, what they did wrong, and what was missing or amiss in their first iteration.

These three steps form a daily on-line cycle. Students complete analyze-create homework on an ongoing basis, and in-classroom problem solving activities to help influence the development of homework. Periodic off-line assessments are recommended at the end of each week starting on the third week of class. During these tests, the student is asked to first reproduce, from memory, their knowledge model on a blank sheet of paper and second, use it to solve a series of novel problems of increasing difficulty. Testing scores will be determined by completeness of the student's model as provided by the student and the answers to the questions presented. The goal is not to get 100% on these tests, but rather assess the students' off-line load capabilities, the efficacy of each solution, and the specific argument behind their approach.

After the first testing period, in-class problem solving activities should be supplemented with case study. The case could either be a fiction or non-fiction situation, but ultimately the goal of this stage is for the student to compare their approach with another previously generated approach. Each case should be followed by a commentary period. For novice groups, this commentary should manifest as informal discussion, but as expertise accumulates, the discussions should seek to evolve into more formalized debates as groups or between individuals. Once case study is introduced, there should be an alternation between problem solving and case study (every other class) until closer to the end of the year where case study should take over.

The final step in this process should focus on off-line communication in which a student is capable of implementing a direct instruction event on a topic to either the class, an instructor, or a panel of faculty without the benefit of pre-prepared materials. In other words, the student should be able to verbally present and answer questions on command using only physical or digital drawing utensil and a surface. The grade from this type of test should be used as the definitive measure of mastery as opposed to the memory and understanding grade. Much like the weekly assessment, it also should only occur after a sufficient benchmark has been reached. Students ready to participate in this activity should be able to achieve approximately an 80% retention of their model (submitted original vs reproduction) and at least a 70-80% score on their answers compared against the instructor's answers to the same questions. To mitigate bias, the test questions and scoring could be drafted and completed by a third party expert and proctor respectively.

Conclusion and Future Directions

The primary purpose of this integrative literature review is to attempt a redesign of Bloom's Taxonomy to realign it with the modern understanding of psychology and make it accessible to a wider audience. In order to accomplish this purpose, a selection of literature was collected from two databases, evaluated, and cross referenced in order to develop a comprehensive model of cognition as a template for the taxonomy redesign. A meta-theoretical model based on an integrated plurality of cognitive theories was synthesized and was used to redesign the taxonomy. Due to the interpretive nature of this endeavor, the success of the redesigned taxonomy will largely depend on its reception, propagation, and perpetuation within the field of education.

Additionally, a similar sentiment applies to the concept of adopting a new way of thinking. Thinking in terms of meta-theory requires a theorist to engage with concepts on a very different level of nuance, much like how some surrealist art in the beginnings of the postmodernist era forced a new perspective in modernist audience. The Rene Magritte painting of the pipe with the caption 'Ce n'est pa un pipe.' (this is not a pipe) presents a sort of paradox in the contradiction between the image and the caption. In order to accurately 'read' this work, one must move outside the work itself and see the more nuanced alignment that the pipe is not a pipe but a *representation* of a pipe. A meta interpretation, at least the one implemented in this paper, makes a similar move but in an even more nuanced way. It acknowledges the image of the pipe as 'a pipe', it acknowledges the truth in the caption that describes the work as 'not a pipe', but instead of stopping there, it makes one more distinction; that the work is 'not *not* a pipe' or is 'sort of a pipe'.

If the representation of the pipe was swapped for anything that was 'not a pipe', then the painting would lose the fundamental contradiction that made it so thought provoking. The image of a boat paired with the caption 'this is not a pipe' is very obvious observation and does not spark a significant enough error between the expectation and the reality to engage more critical thought. Although the original sentiment is still true that the painting is not itself a pipe, it also must be true that it cannot be completely divorced from the concept of pipes altogether. It is not just a representation of a pipe; it *must be* a representation of a pipe.

There can't be a single totalizing theory of cognition, because each perspective within the model adds in an important, proven facet of cognition. Some of these facets work against one another which are inherently irreconcilable so attempting to cram everything into a single explanation would be impossible. But on the flip side, there can't *not* be a single totalizing theory of cognition because in order for meaningful discussion to take place on cognition, theorists need to acknowledge that cognition needs to manifest as a coherent concept. One possible means of balancing these two ideas is to consider larger scale theories as emergent constraints, sort of like a tool box for tools. While no one tool can do every job, one needs the best suited tool for each job. Applying this type of thinking to other facets of psychology and education could offer a means of reengaging with concepts through the lens of emergence.

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Appendix A.

Sampling Process Table

Sampling - Time (Custom Range 2001-2025)	Database (Records Results)	
Terms Used in Basic Search (Between First Quotations)	Google Scholar(n)	Semantic Scholar(n)
"Embodied Cognition Theory literature review summary"	N = 17,800	N = 9,910
"Predictive Coding and Bayesian Brain Theory Literature Review"	N = 18,700	N = 53
"Connectionism Neural Network Theory Literature Review"	N = 18,000	N = 10,300
""Dual Process Theory" of Cognition Literature Review"	N = 17,000	N = 1,890
"Cognitive Load Theory Literature Review"	N = 17,800	N = 10,400
"Cognitive Control and Executive Function Theories Literature Review"	N = 17,900	N = 1,520
"Cognitive Neuroscience of Memory Theories Literature Review"	N = 17,800	N = 1,640
"Social and Cultural Cognition Theories Literature Review"	N = 17,800	N = 6,530
""Integrated Information Theory" of Cognition Literature Review"	N = 3,640	N = 2,040
""Dynamic Systems Theory" Literature Review"	N = 17,200	N = 48,600

Screening - Filtered by Title and Abstract	Database (Records Selected)		
Theory Category	Google Scholar(n)	Semantic Scholar(n)	Total Per Category (n)
Embodied Cognition Theory	N = 6	N = 5	N = 11
Predictive Coding and Bayesian Brain	N = 6	N = 4	N = 10
Connectionism Neural Network Theory	N = 6	N = 0	N = 6
Dual Process Theory	N = 6	N = 3	N = 9
Cognitive Load Theory	N = 6	N = 3	N = 9
Cognitive Control and Executive Function Theories	N = 6	N = 2	N = 8
Cognitive Neuroscience of Memory Theories	N = 9	N = 2	N = 11
Social and Cultural Cognition Theories	N = 6	N = 1	N = 7
Integrated Information Theory	N = 5	N = 2	N = 7
Dynamic Systems Theory	N = 6	N = 1	N = 7
Total Records Selected			N = 85

Eligibility - Filtered By AMSTAR2 Checklist, and Annotated Bibliography	Total Category Records (Records Removed)
Theory Category	Total Per Category (n)
Embodied Cognition Theory	N = 4
Predictive Coding and Bayesian Brain	N = 0
Connectionism Neural Network Theory	N = 1
Dual Process Theory" of Cognition Literature Review	N = 1
Cognitive Load Theory	N = 2
Cognitive Control and Executive Function Theories	N = 1
Cognitive Neuroscience of Memory Theories	N = 1
Social and Cultural Cognition Theories	N = 1
Integrated Information Theory	N = 1
Dynamic Systems Theory	N = 1
Total Records Removed	N = 13

Included- Screened Records Remaining After Eligibility	Total Category Records (Records Included After Filtration)
Theory Category	Total Per Category(n)
Embodied Cognition Theory	N = 7
Predictive Coding and Bayesian Brain	N = 10
Connectionism Neural Network Theory	N = 5
Dual Process Theory	N = 8
Cognitive Load Theory	N = 7
Cognitive Control and Executive Function Theories	N = 7
Cognitive Neuroscience of Memory Theories	N = 10
Social and Cultural Cognition Theories	N = 6
Integrated Information Theory	N = 6
Dynamic Systems Theory	N = 6
Total Records Included	N = 72

Appendix B.

Eligibility - Filtered By AMSTAR2 Checklist, and Annotated Bibliography

Note: The following table consists of 85 sub-tables, each representing the filtration process for a single record. Each sub-table consists of the following 4 parts: a) Unique Identifier, b) AMSTAR 2 Scoring, c) Annotation, and d) Citation. The Unique Identifier is a code comprised of from the abbreviation of the theory category (e.g. Embodied Cognition = EC), the database from which the record was selected (e.g. Google Scholar = GS), and the record number (i.e. The first Embodied Cognition record selected from Google Scholar = ECGS1). The AMSTAR 2 Checklist component is an itemized accounting of the responses (either yes, partial, no, or N/A) to each of the 16 checklist questions. The responses to each of the questions on the checklist are recorded in the following manner: a) 1= Yes, b) .5 = partial, and c) 0 = No or N/A. The Summary of Work and Reasons for Inclusion/Exclusion component is a summary of each record and the qualitative reasoning behind its inclusion and exclusion in the integrative literary analysis. The citation is the APA citation of each selected record.

EC(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper presents an overview of the empirical research conducted on the topic of embodied cognition and recommends a research strategy for future research. The authors first establish the standard cognitive approach to explaining behavior, briefly discuss instances of research directed towards the 'replacement hypothesis', and then build their recommended strategy from these cases. This paper does not include any quantitative data, nor does it follow a particular systemic review methodology.

This paper will be included in the integrative literature review because it provides a broad overview of the research into this theory as well as introduces a number of theory facets such as the 'replacement hypothesis' which will be used to develop a more comprehensive summary of this theory.

Note: Wilson, A. D., & Golonka, S. (2013). Embodied cognition is not what you think it is. *Frontiers in psychology*, *4*, 58. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2013.00058/full

EC(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper "distinguishes and evaluates" six claims posited by the theory of embodied cognition. The claims are briefly introduced in the opening segment of the work, each claim is then evaluated in more depth, and finally the author synthesizes their evaluative thoughts in the conclusion. This paper does not include any quantitative data, nor does it follow a particular systemic review methodology.

This paper will be included in the integrative literature review is because it surveys and critically evaluates a number of perspectives within this theoretical approach. While it does not operate using a systemic review methodology, it synthesizes a number of mid-level to program-level papers in order to first introduce each claim which could prove useful in establishing a 'genealogy' of conceptualization from program-level work to grand-level claims.

Note: Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review*, *9*, 625-636. https://doi.org/10.3758/bf03196322

EC(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This essay presents a broad overview of the recent work into Embodied cognition; in the course of six distinct section, it presents the basics of the classical approach to Artificial Intelligence and its criticism to contextualize the reason behind the new theoretical direction, establishes the alternative approach, navigates the different uses of the term 'embodiment' found in the literature, emphasizes the importance of society in human level intelligence, reviews criticisms of EC, and discusses implications of the theoretical direction. This essay does not include any quantitative data, nor does it follow a particular systemic review methodology.

This essay will be included because it broadly introduces the origins of this theoretical approach at a grand-theoretical level, it introduces the concept of the 'physical grounding project', and it also critically examines this field of research and its implications.

Note: Anderson, M. L. (2003). Embodied cognition: A field guide. *Artificial intelligence*, *149*(1), 91-130. https://doi.org/10.1016/S0004-3702(03)00054-7

EC(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper offers a brief introduction to 'radical embodied cognitive science' which is an offspring of the Jamesian School of Functionalist Psychology. Its main topic is to illustrate the nature of this approach to cognitive science, its connection with past psychological and philosophical approaches to cognition, and how its research may manifest. The end of the article features a brief anecdote of an experiment

performed by the author which is meant to provide the reader with a sense of how others might pursue investigation into the topic, but no detailed descriptions of the participant groups, or experimental results data were included.

This paper will be excluded because although it offers some degree of insight into the research aspect of embodied cognition and its genealogy with respects to other psychological movements, it doesn't explicitly discuss the theory of embodied cognition enough to merit inclusion.

Note: Chemero, A. (2013). Radical embodied cognitive science. *Review of General Psychology*, *17*(2), 145-150. https://doi.org/10.1037/a0032923

EC(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2

Summary of Work and Reasons for Inclusion/Exclusion

This systematic review covers the literature involving embodied cognition. While the review failed to pass the AMSTAR review tool, the author did provide a somewhat brief explanation of their methodology for inclusion and exclusion of papers from the review. The purpose of this review was to cover the mainstream investigation into EC and the overall findings of the empirical research. This work does not include any major quantitative meta-analysis, though it does survey the types of Technologies for EC in Education.

This paper will be included because it offers a mid-level perspective into EC research, and because the work is a systematic review of the empirical work, the citations included provide further means of investigating the quantitative aspect of EC research, which could be useful in establishing a broader genealogy.

Note: Kosmas, P., & Zaphiris, P. (2018). Embodied cognition and its implications in education: An overview of recent literature. *International Journal of Educational and Pedagogical Sciences*, *12*(7), 930-936. https://web.archive.org/web/20200306102200/https://zenodo.org/record/1340510/files/10009334.pdf

EC(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This essay argues for a pluralistic theory of conceptual embodiment that takes into account both embodied cognition and dis-embodied cognition. The argument unfolds over three sections in which the author outlines the embodied approach to simulated concepts, examines the problem of abstraction, and reviews evidence of separate semantic codes which seems to necessitate an additional theory for abstract concepts. This essay does not include any quantitative data, nor does it follow a particular systemic review methodology.

This essay will be included because it discusses a core problem with the embodied cognition approach, namely the problem of abstraction, but also suggests a possible solution which may tie into other theoretical approaches on the review list. Despite the examination of the problem of abstraction, the paper also discusses why the solution also need to include embodied cognition as a component, thereby suggesting a more balanced approach to the topic of EC.

Note: Dove, G. (2011). On the need for embodied and dis-embodied cognition. *Frontiers in Psychology*, *1*, 242. https://doi/10.3389/fpsyg.2010.00242

EC(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2

Summary of Work and Reasons for Inclusion/Exclusion

This systematic review covers the literature involving embodied cognition. While the review failed to pass the AMSTAR review tool, the author did provide a somewhat brief explanation of their methodology for inclusion and exclusion of papers from the review. The purpose of this review was to cover the main stream investigation into Embodied Cognition and the overall findings of the empirical research. This work does not include any major quantitative menta-analysis, though it does survey the types of Technologies for EC in Education.

This review will be excluded because it is a duplicate of ES(GS)5 (which is already included.

Note: Kosmas, P., & Zaphiris, P. (2018). Embodied cognition and its implications in education: An overview of recent literature. *International Journal of Educational and Pedagogical Sciences*, *12*(7), 930-936. https://web.archive.org/web/20200306102200/https://zenodo.org/record/1340510/files/10009334.pdf

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EC(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	.5	0	0	0	0	0	0	0	0	.5

Summary of Work and Reasons for Inclusion/Exclusion

This review examines the theory of Embodied Cognition as it applies to older populations. The main focus is to present research into the differences between embodiment in older and younger populations, and how this theory could be used to explain concurrent physical and

mental changes during the aging process. The authors discuss a range of topics including but not limited to sensory perception and integration, the body schema and peripersonal space, mental and motor imagery, and tool use.

This review will be included because, although it focuses on elderly populations, the article provides enough general insights into the theory to be useful for cross referencing concepts with the other EC articles, and it also provides insights as to the limits of EC theory.

Note: Costello, M. C., & Bloesch, E. K. (2017). Are older adults less embodied? A review of age effects through the lens of embodied cognition. *Frontiers in psychology*, *8*, 267. https://doi.org/10.3389/fpsyg.2017.00267

EC(SS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article examines higher vocational college English teaching using EC as a theoretical lens and as a means of strategizing. The article begins with an introduction of the context and the problems within higher vocational college English learning, it briefly discusses the theoretical background, presents ways in which it could be applied to various learning situations within this context, and concludes with a series of open ended questions.

The article will be excluded because its scope is limited to context of high vocational college in China, which seems to suggest that this article operates at more of a programmatic level as opposed to a mid or grand level of theorization. This article also does not provide any unique insights regarding to EC theory.

Note: Zhang, N. (2018, March). Higher Vocational College English Teaching and Learning Based on Embodied Cognition Theory. In *2nd International Conference on Culture, Education and Economic Development of Modern Society (ICCESE 2018),* 346-348. Atlantic Press. https://doi.org/10.2991/iccese-18.2018.81

EC(SS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper explores the topic of embodiment of situation models in human cognition. The primary research question was whether or not individuals, while reading a passage of text, could 'simulate' elements that were not explicitly described in the text but may be closely related to the explicitly described situation. The experiments included in this paper consisted of a neurological imaging study in which participants reading action words while being examined by a 'functional localizer', and a transcranial magnetic stimulation study in which participants were asked to determine if a word on a screen was in English before receiving transcranial magnetic stimulation. The paper then concludes with a summary of the paper and possible directions for future research.

This paper will be excluded because of its vagueness regarding the experiments mentioned, the lack of unique perspective on EC theory, and its narrow research question.

Note: Jin, B., Wu, Y., & Lo, C. K. (2021, December). Are Situation Models Embodied?. In *2021 4th International Conference on Humanities Education and Social Sciences (ICHESS 2021),* 2710-2715. Atlantic Press. https://doi.org/10.2991/assehr.k.211220.468

EC(SS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	.5	0	0	0	0	0	0	0	1	1.5

Summary of Work and Reasons for Inclusion/Exclusion

This review presents an interpretation of EC through Cognitive Load (CL) theory. The authors suggest that based on embedded/embodied cognition studies, individuals alleviate cognitive load by shifting some of the effort to the environment (embedded cognition), and that transfer of learning involves internalizing sensorimotor experiences from manipulatives (embodied cognition).The paper first focuses on examining the embedded cognition claim then shifts to examining the embodied claim.

This paper will be included because it touches on the unique perspective of embedded cognition, it mentions the distinction between 'on-line' vs 'off-line' cognition which also occurs in other papers within this selection, and it provides a bridge between embodied cognition and cognitive load which will help with the construction process for the Bloom's Taxonomy model.

Note: Pouw, W. T., Van Gog, T., & Paas, F. (2014). An embedded and embodied cognition review of instructional manipulatives. *Educational Psychology Review*, *26*, 51-72. https://doi.org/10.1007/s10648-014-9255-5

PC&BB(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This review is a brief attempt at summarizing and combining the theories of Predictive Coding and Bayesian Brain into a single framework. The work begins with a brief over view of both theoretical perspectives and the mathematical formulas used to encapsulate their core meaning. It finally concludes with the synthesis of the two perspectives. Included along with the mathematical formulae are graphical representations of results from some of the supporting material.

This review will be included because it offers useful background information regarding predictive coding and Bayesian inference. This work also includes reference to some neurological aspects of cognition which could tie into the Cognitive Neuroscience of Memory portion of the integrative literary review.

Note: Aitchison, L., & Lengyel, M. (2017). With or without you: predictive coding and Bayesian inference in the brain. *Current opinion in neurobiology*, *46*, 219–227. https://doi.org/10.1016/j.conb.2017.08.010

PC&BB(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the literature on predictive processing models of brain function to study clinical (psychiatric) disorders. The main aim of this work is to highlight directions and discuss their potential benefit in clinical application. While this article is intended for more clinical purposes, the focus is on the theoretical models. It opens with an overview of the predictive model and then proceeds to introduce illustrative examples as well as formal models, empirical studies, and their findings.

This review will be included because it provides more detailed models of how predictive models manifest neurologically. It also includes a neural network diagram in its formal models section which could provide bridging material between predictive coding and connectionist neural network theory, thereby helping to orient this theory amongst the others.

Note: Smith, R., Badcock, P., & Friston, K. J. (2021). Recent advances in the application of predictive coding and active inference models within clinical neuroscience. *Psychiatry and clinical neurosciences*, *75*(1), 3–13. https://doi.org/10.1111/pcn.13138

PC&BB(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article focuses heavily on the neural elements of predictive coding. The aim of the work is to bridge the theory of predictive coding with cortical microcircuitry, resulting in an informational cross-supporting structure that illustrates how the software of the mind interfaces with the hardware of the brain so to speak. The work begins from the theoretical perspective and gradually works into the physical architecture of the microcircuitry before returning to a broader theoretical perspective in the summary.

This article will be included because it provides a wealth of neurological knowledge which may coincide with both the connectionist neural network theory as well as the Cognitive Neuroscience of Memory theory. This work also provides a detailed description of the flow of information from basic sensory stimulation to deep integration and back which may also tie into integrated information theory.

Note: Shipp S. (2016). Neural Elements for Predictive Coding. *Frontiers in psychology*, *7*, 1792. https://doi.org/10.3389/fpsyg.2016.01792

PC&BB(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

The review focuses on the role of top-down processes in the suppression of repetition in neural processes. The researchers seek to provide what they believe to be a balanced conversation on work that both supports and refutes the explanation; in this conversation, they cite measurement comparisons as a possible culprit of the confusion. The work does include basic descriptions of empirical work but fails to meet the criteria of the AMSTAR.

This work will be included because it provides a comparison of top-down vs bottom-up processing which isn't present in the previous articles. The work also includes a macroscopic model of how predictive coding occurs across larger brain structures beyond the cortex.

Note: Grotheer, M., & Kovács, G. (2016). Can predictive coding explain repetition suppression?. *Cortex; a journal devoted to the study of the nervous system and behavior*, *80*, 113–124. https://doi.org/10.1016/j.cortex.2015.11.027

PC&BB(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review is an exploration of predictive coding. The article begins from a formalized mathematical perspective, introduces examples of predictive coding in the context of processing spatial and temporal events, and concludes with a discussion of how predictive coding integrates with current neuroscience. The article includes quantitative data reprints from supporting sources and examples of empirical studies.

This review will be included because it provides an example of how predictive coding can explain how we process the perception of space and time. It also adds more specific mathematical perspectives which do not appear in any of the previous articles collected.

Note: Huang, Y., & Rao, R. P. N. (2011). Predictive coding. *Wiley interdisciplinary reviews. Cognitive science*, *2*(5), 580–593. https://doi.org/10.1002/wcs.142

PC&BB(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper presents an argument for an embodied predictive coding model. The author's goal is to combine embodied cognition and predictive coding into an explanatory framework to account for how or predictive coding strategy is linked to our embodied existence. The explanation begins with the question of why hearing a window squeaking in the middle of the night suggests the idea of a killer or a thief entering into a household and uses this scenario as a means of extending the predictive coding framework to include physiological perceptions of bodily condition.

This paper will be included because it provides a unique perspective by linking embodied cognition and predictive coding. Its inclusion of the Baye's rule application within the context of predictive coding also offers some level of insight into the Bayesian Brain.

Note: Pezzulo, G. (2014). Why do you fear the bogeyman? An *embodied predictive coding* model of perceptual inference. *Cognitive, Affective & Behavioral Neuroscience, 14*(3), 902–911. https://doi.org/10.3758/s13415-013-0227-x

PC&BB(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review presents a comprehensive exploration of the theory of predictive coding. It predominantly covers the mathematics and logic behind predictive coding phenomenon, paradigms within the theoretical perspective, and the relationship between predictive coding and other algorithmic approaches to cognition.

This review will be included because the breadth of knowledge included accounts for a number of possible connections with other theories, namely cognitive control theory. This work also includes references to sources connected to embodied cognition which may further reinforce this theories position within the finalized model.

Note: Millidge, B., Seth, A., & Buckley, C. L. (2021). Predictive coding: a theoretical and experimental review. *arXiv preprint arXiv:2107.12979*.

PC&BB(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.	1

Summary of Work and Reasons for Inclusion/Exclusion

This article explores the topic of active inference and enactive inference. The aim of the paper is to clarify some of the misconceptions involving the conflation of active inference with the free energy principle and predictive coding, predictive processing, or the prediction error minimization framework. In order to accomplish this goal, the authors introduce an enactive interpretation in the form of enactive inference to create more distinction away structuralist interpretations,

This article will be included because its topic offers new information in the form of enactive inference on how predictive coding links to embodied cognition. It also offers insight into the structuralist/functionalist dichotomy which may be useful in the model construction process.

Note: Ramstead, M. J., Kirchhoff, M. D., & Friston, K. J. (2020). A tale of two densities: active inference is enactive inference. *Adaptive behavior*, *28*(4), 225–239.

PC&BB(SS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter discusses memory consolidation during sleep and how consolidation connects to the theory of predictive coding. The authors review the evidence for memory traces and their consolidation and transformation during the sleep cycle. They then argue that the model which best explains the process can be found in predictive coding theory. While the article briefly touches on experiments into the phenomena, the descriptions are not sufficient to pass AMSTAR criteria.

This chapter will be included because it discusses predictive coding from the perspective of memory consolidation during sleep which offers a perspective not presented in any of the previous papers. And despite the previous papers frequent reference to the neurological aspects of predictive coding, this work seems to provide a much more direct link to the Cognitive Neuroscience of Memory.

Note: Rauss, K., & Born, J. (2017). A role of sleep in forming predictive codes. In N. Axmacher & B. Rasch (Eds.), *Cognitive neuroscience of memory consolidation* (pp. 117–132). Springer International Publishing. https://doi.org/10.1007/978-3-319-45066-7_8

PC&BB(SS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article offers another overview of the theory of predictive coding, but unlike the previous articles, this one discusses the Bayesian brain perspective more explicitly. The article opens by discussing the Bayesian Brain hypothesis, then moves on to discussing the Free energy Principle followed by Active Inference. Finally, the article concludes with examining PCT through neurological models.

This article will be included because it is the first article to discuss, in length, the Bayesian Brain Hypothesis which seems to be a distinct though closely related theory to predictive coding. This article asl contains a useful diagram of the Free-Energy principle.

Note: Giglia, G., & Ognibene, D. (2018). Changing perspective on perception physiology: Can you really see what is happening?. *EuroMediterranean Biomedical Journal*, *13*(33), 145-149. http://dx.doi.org/10.3269/1970-5492.2018.13.33

CNN(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter offers a fairly comprehensive look into the origins and main ideas of connectionist theory. It covers some of the earliest experiments using artificial neural networks, some of the connections to Bayesian Inference, and also some of the theoretical limitations of connectionism. The chapter contains mainly diagrams of neural network arrangements and some graphs attached to word processing experiments.

This book chapter will be included because it offers a solid foundation for the theoretical perspective of connectionism as well as some connections towards Bayesian Inference. This work also offers a solid historical account of the theory which may proof helpful in developing the Bloom's Taxonomy model.

Note: Thomas, M. S. C., & McClelland, J. L. (2008). Connectionist models of cognition. In R. Sun (Ed.), *The Cambridge handbook of computational psychology* (pp. 23–58). Cambridge University Press. https://doi.org/10.1017/CBO9780511816772.005

CNN(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article briefly presents a pro-connectionist assessment of the early empirical research into neural networks. It also briefly highlights some of the challenges of the research direction. The article contains very little in the way of empirical studies and no meta-analysis.

This article will be excluded because based on its age, it may be too old to be considered relevant. It also admits a pro-connectionist bias which may prove detrimental if it were to be used in the integrative literature review process.

Note: Elman J. L. (2005). Connectionist models of cognitive development: where next?. *Trends in cognitive sciences*, *9*(3), 111–117. https://doi.org/10.1016/j.tics.2005.01.005

CNN(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article provides a 25 year summary of the research into connectionist neural networks for knowledge discovery. Topics include fuzzy neurons/networks, evolving spiking neural networks, and evolving computational neuro-genic models. The paper mainly features neural network diagrams, formal logic used to explain the networks function, and some graphs which depict the output of said network.

This article will be included because it covers several novel topics within the field of connectionist theory such as fuzzy neurons/ fuzzy neural networks, rule-based systems, and connectionist memory networks.

Note: Kasabov, N. K. (2015). Evolving connectionist systems for adaptive learning and knowledge discovery: Trends and directions. *Knowledge-Based Systems*, *80*, 24-33. https://doi.org/10.1016/j.knosys.2014.12.032

CNN(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article addresses the intersection between connectionist theories, working memory and cognitive control. The core argument is that these facets of cognition are the result of competition between distributed representations. The article predominantly includes diagrams generated from synthesis of research findings however these diagrams are not metanalyses of the synthesized research.

This article will be included because of its discussion regarding 'global workspace theory' which offers a unique perspective to the connectionist theory model. This work also provides an explicit connection between connectionism and cognitive control theory.

Note: Maia, T. V., & Cleeremans, A. (2005). Consciousness: converging insights from connectionist modeling and neuroscience. *Trends in cognitive sciences*, *9*(8), 397–404. https://doi.org/10.1016/j.tics.2005.06.016

CNN(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter explores the relationship between connectionist neural network approaches to memory and how they relate to statistical inference and symbolic model of the mind. This work hopes to use the relationship between statistics and neural network processing as a means of establish the theory within the field of cognitive science. This work also hopes to situate this approach alongside symbolic psychology as opposed to argue for its replacement.

This chapter will be included because it presents a unique perspective on the statistical vs the symbolic approaches to psychology. It also argues for a pluralistic approach that incorporates both approaches as equally valid in the pursuit of psychology which may offer insight into pluralistic interpretations of cognitive science.

Note: Chater, N. (2014). Neural networks: The new statistical models of mind. *Connectionist Models of Memory and Language (PLE: Memory)*, 207-227.

CNN(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This opinion piece focuses on how connectionist models explain human thought, language, and behavior as an emergent phenomenon derived from the collective activity of smaller 'non-cognitive' processes. The article argues that connectionist models will be essential in order to fully understand cognition and development. The article includes definitions of terms associated with connectionist theory as well as some description of an empirical study into the A-not-B error.

This article will be included because it comments on the A-not-B error which is a unique perspective, and it also comments on the structure/function relationship. In addition to these contributions, this article connects connectionist theory with dynamic field theory and systems theory.

Note: McClelland, J. L., Botvinick, M. M., Noelle, D. C., Plaut, D. C., Rogers, T. T., Seidenberg, M. S., & Smith, L. B. (2010). Letting structure emerge: connectionist and dynamical systems approaches to cognition. *Trends in cognitive sciences*, *14*(8), 348–356. https://doi.org/10.1016/j.tics.2010.06.002

DPT(GS)1

AAMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article focuses on the debate regarding dual-process theory. It seeks to highlight 5 criticisms of the theory and provide a balanced response. The article provides an overview of the different versions of dual-process theory, definitions of terminology, a diagram of one of the versions, and two brief accounts of experiments into the phenomenon.

This article will be included because it offers a broad perspective of the theory and its several versions. It also provides valuable insight into the debate underlying the development of this theoretical perspective.

Note: Evans, J. S., & Stanovich, K. E. (2013). Dual-Process Theories of Higher Cognition: Advancing the Debate. *Perspectives on psychological science : a journal of the Association for Psychological Science*, *8*(3), 223–241. https://doi.org/10.1177/1745691612460685

DPT(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This critical review addresses the issue of defining the two types of thinking within dual-processing theory. The author's aim is to explore some of the implications for either adopting or rejecting certain definitions of these thinking types. Overall, the article focuses on the theoretical discussions and does not include much in the way of empirical studies description or findings.

This article will be included because of its discussion of the Token Thesis and the Cognitive Kind Thesis which could provide valuable insight regarding the macroscopic development of the Bloom's Taxonomy system.

Note: Bellini-Leite, S. C. (2018). Dual process theory: Systems, types, minds, modes, kinds or metaphors? A critical review. *Review of Philosophy and Psychology, 9*(2), 213–225. https://doi.org/10.1007/s13164-017-0376-x

DPT(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article presents the contemporary state of dual process theory investigation up to 2011 with an emphasis of the number of versions of dual-process theory. The aim of the author is demonstrate the complexity of the theory and challenge the notion that dual-process theory is squarely set on 'dual' processes. The article also argues against the continues use of the term 'Systems' when discussing different types of thinking.

This article will be included because it discusses the interventionist model of dual process theory as well as argues from the perspective of a theorist seeking to abandon the 'two-system' concept of this theory.

Note: Evans, J. S. B. (2011). Dual-process theories of reasoning: Contemporary issues and developmental applications. *Developmental review*, *31*(2-3), 86-102. https://doi.org/10.1016/j.dr.2011.07.007

DPT(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article provides an overview of DPT from a philosophical perspective. The author aims to point out the coherences and dissonances between DPT and Thomistic and Aristotelian views of behavior. The author also hopes to discuss the implications of DPT with respects to virtue development.

Although this article is from a philosophical journal as opposed to a cognitive scientific one, it will be include because a) the author's arguments are built on references to DPT literature from cognitive psychology sources, and b) their perspective sheds light on the status of DPT up to 2022. Approaching this theory from a non-scientific perspective may also aid in how DPT is integrated into the Bloom's Taxonomy framework.

Note: Beary, A. (2022). Dual process theory: A philosophical review. *American Catholic Philosophical Quarterly*, *96*(2), 317-344. http://dx.doi.org/10.5840/acpq202221250

DPT(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article, also written, from the philosophical perspective, provides a general overview of DPT up to 2010. The aim is to introduce the topic and doesn't seek to argue for any particular conceptualization. The article covers precursors to the dual process theory, specifically Freud's concept of the conscious and unconscious mind, as well as possible applications of the theory to philosophical problems such as Nagel's paradox of knowledge.

This article will be included because it could be valuable in corroborating some of the points from the other papers surveyed, and it also offers an additional non-scientifically oriented perspective which could benefit this meta-theoretic approach.

Note: Frankish, K. (2010). Dual-process and dual-system theories of reasoning. *Philosophy Compass*, *5*(10), 914-926. http://dx.doi.org/10.1111/j.1747-9991.2010.00330.x

DPT(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article is a response to Evans and Stanovich (2013) (DPT(GS)1). The aim of this commentary is to consider he characteristics of the two types of thinking posited by DPT and suggest that the evidence can also be interpreted as quantitative differences in processing as opposed to two qualitative differences. While the article includes references to empirical evidence, it does not go into detail about the studies used to gain said evidence.

This article will be included as it offers a continuation on the first article, and its interpretation of the first articles evidence as quantitative differences between T1 and T2 thinking could affect how the model for the integrative literature review is holistically conceptualized.

Note: Osman, M. (2013). A case study: Dual-process theories of higher cognition—Commentary on Evans & Stanovich (2013). *Perspectives on Psychological Science, 8*(3), 248–252. https://doi.org/10.1177/1745691613483475

DPT(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	1	0	1	.5	1	1	1	.5	0	0	0	0	0	0	0	1	7

Summary of Work and Reasons for Inclusion/Exclusion

This systemic review focuses on the topic of integrative complexity and decision making. The aim of this work is to determine how research on decision making with IC perceived cognitive processes and if combining IC and neuroscience provide a more precise analysis of the decision making process. The review interprets its findings through the activity theory model.

This review, although very high quality, will be excluded because it does not discuss dual-process theory.

Note: Molina, I., Molina-Perez, E., Sobrino, F., Tellez-Rojas, M. A., Zamora-Maldonado, H. C., Plaza-Ferreira, M., Orozco, Y., Espinoza-Juarez, V., Serra-Barragán, L. & De Unanue, A. (2023). Current research trends on cognition, integrative complexity, and decision-making: a systematic literature review using activity theory and neuroscience. *Frontiers in Psychology*, *14*, 1156696. https://doi.org/10.3389/fpsyg.2023.1156696

DPT(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This paper discusses DPT within the context of clinical reasoning. The aim of the article is to explain how DPT could be used to improve curricula in clinical education by providing an explanatory model that could be used to guide the curriculum design process. The article features mostly theoretical discussion as well as a few graphic representations of the concepts being discussed.

This paper will be included because it provides an account of how DPT interlinks with metacognition and it also includes some commentary on expertise development.

Note: Marcum J. A. (2012). An integrated model of clinical reasoning: dual-process theory of cognition and metacognition. *Journal of evaluation in clinical practice*, *18*(5), 954–961. https://doi.org/10.1111/j.1365-2753.2012.01900.x

DPT(SS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the topics of dual process theory and paradoxes. The aim of the article is to synthesize the literature on these topics into a composite framework. The review synthesizes the findings from approximately 180 various types of sources, offers overviews of both paradox theory and DPT separately, and discusses the various results of integrating intuition and analysis. The reason for the low score on the AMSTAR evaluation was the lack of risk of bias assessment methods as well as lack of some elements described within the testing framework.

This article will be included because it provides a thorough investigation of the 2 types of though covered by DPT from a number of perspectives.

Note: Keller, J., & Sadler-Smith, E. (2019). Paradoxes and dual processes: A review and synthesis. *International Journal of Management Reviews, 21*(2), 162–184. https://doi.org/10.1111/ijmr.12200

CL(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article broadly focuses on the work into Cognitive Load Theory. The author's aim is to investigate some of the theoretical inconsistencies and draw conclusions about the future directions for the theory. This article outlines the history of the theory and basic assumptions of the theory, discusses the types of cognitive load described by the theory, compares this theory with Vygotzky's Zone of Proximal Development, and finally investigates how this theory interacts with the theory of working memory.

This article will be included because it offers a broad view of the theory and touches on contradictory perspectives which may prove useful in integrating this theory within the Bloom's Taxonomy model.

Note: Schnotz, W., & Kürschner, C. (2007). A reconsideration of cognitive load theory. *Educational Psychology Review, 19*(4), 469–508. https://doi.org/10.1007/s10648-007-9053-4

CL(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article examines cognitive load theory within the context of instructional design for health professional education. The aim of the work is to discuss a design strategy conceived using cognitive load theory that is intended to reduce extraneous load, manage intrinsic load, and optimize germane load. This article includes predominantly discussion with very little description of empirical studies or statistical data.

This article will be included because it discusses the three types of load in more detail as well as elaborates on how design elements are able to address each type.

Note: van Merriënboer, J. J., & Sweller, J. (2010). Cognitive load theory in health professional education: design principles and strategies. *Medical education*, *44*(1), 85–93. https://doi.org/10.1111/j.1365-2923.2009.03498.x

CL(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter focuses mainly on the intrinsic relationship between human cognitive architecture and cognitive load theory. The aim of this work is to argue as to the necessity of taking human cognitive architecture into account when engaging in instructional design. The article approaches this topic using biological explanations, including evolutionary perspectives, to illustrate why cognitive load theory adequately addresses human cognitive architecture concerns in instructional design.

This article will be included as it provides a unique approach to understanding the theory from a biological perspective as well as an information processing perspective.

Note: Sweller, J. (2011). Cognitive load theory. In J. P. Mestre & B. H. Ross (Eds.), *The psychology of learning and motivation: Cognition in education* (pp. 37–76). Elsevier Academic Press. https://doi.org/10.1016/B978-0-12-387691-1.00002-8

CL(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article provides a retrospective look at the development of Cognitive Load Theory over a span of 20 years. The aim of this work is to comment on the growth of the theoretical perspective and speculate as to the theory's future developments. The article contains detailed discussions regarding the instructional effects caused by the theory in practice as well as intersections of CL with other learning theories.

This article will be included because it provides a more recent perspective than the previous articles, the discussion of the theories effects may be useful in orienting the theory within the larger framework, and the article suggests possible connections to embodied cognition.

Note: Sweller, J., van Merriënboer J. J., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. *Educational psychology review*, *31*, 261-292. https://link.springer.com/article/10.1007/s10648-019-09465-5

CL(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article discusses expertise reversal for learner-tailored instruction. The aim is to review a selection of empirical studies related to this phenomenon and interpret their findings through the lens of cognitive load theory. While this article does present a survey of said studies and their effect sizes, these results are not presented as a meta-analysis in which the results were synthesized into a single data set, which is why this review did not receive any 'points' for the AMSTAR evaluation. The scoring is based on a stringent adherence to the literal interpretations of the question.

This review will be included because it offers an example of cognitive load theory's application with respects to expertise reversal, which may offer some indication as to how theorists understand the theory and how that understanding might map onto either a facet of Bloom's Taxonomy or Bloom's Taxonomy as a whole.

Note: Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational psychology review*, *19*, 509-539. https://doi.org/10.1007/s10648-007-9054-3

CL(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter discusses the split-attention effect element of cognitive load theory. The aim of the chapter is to explain why presenting information that needs to be considered simultaneously needs to be presented without any spatial or temporal gaps. The chapter included a number of diagrams which better illustrate the concept in a graphical sense.

This chapter will be excluded because its focus seems to fall to narrowly on only a single aspect of the theory. In depth coverage of this facet may detract from the overall goal of the review.

Note: Sweller, J., Ayres, P., & Kalyuga, S. (2011). The split-attention effect. *Cognitive load theory*, 111-128. https://doi.org/10.1007/978-1-4419-8126-4

CL(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	.5	0	0	0	0	0	0	0	0	0	0	0	1	1.5

Summary of Work and Reasons for Inclusion/Exclusion

This systematic review covers the literature involving cognitive load theory as applied to health education. The aim of this article is to synthesize broad themes from the articles collected on the topic of cognitive load theory. The article includes a list of empirical studies with some light descriptions.

This article will be included because it provides a fairly strong synthesis of literature, despite its poor AMSTAR score. While it failed to meet the test's standards, the article corroborates several points from some of the previous articles reviewed and includes a synthesized list of themes which could prove useful in the theory's orientation within the larger model.

Note: Ghanbari, S., Haghani, F., Barekatain, M., & Jamali, A. (2020). A systematized review of cognitive load theory in health sciences education and a perspective from cognitive neuroscience. *Journal of education and health promotion*, *9*, 176. https://doi.org/10.4103/jehp.jehp_643_19

CL(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the topic of well being and cognitive load. The aim of the work is to survey the literature involving well being as an agent for cognitive reduction. The work includes an overview of the CLT as well as a diagram representation, a definition of well being, a list of the instruction effects for cognitive load theory, and discussion regarding emotional interactions and pain interactions with cognitive load.

This article will be included because its unique perspective may offer connections with embodied cognitive theories, thereby better situating the theory within the final model.

Note: Hawthorne, B. S., Vella-Brodrick, D. A., & Hattie, J. (2019). Well-being as a cognitive load reducing agent: a review of the literature. *Frontiers in Education, 4*, 121. https://doi.org/10.3389/feduc.2019.00121

CL(SS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review discusses cognitive load theory within the context of medical education. The aim of the article is to synthesize the current research (up to 2015) on the topic of CLT and generate a holistic model which can be applied in the field of medical education. This review mainly focuses on presenting a set of recommendations for building medical education curricula around the principle of cognitive load theory.

This theory will be excluded because this review already features multiple articles referencing the application of cognitive load theory to medical education.

Note: Leppink, J., & van den Heuvel, A. (2015). The evolution of cognitive load theory and its application to medical education. *Perspectives on medical education*, *4*(3), 119–127. https://doi.org/10.1007/s40037-015-0192-x

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CC&EF(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article focuses on the role of the prefrontal cortex in cognitive control and executive function. The aim is to investigate the questions of a) whether or not CC should be considered a unitary construct or a set of component processes, b) if the later, then how many of these sub components can be identified, and or c) is cognitive control an emergent phenomenon from neurological processing in the brain. The article includes anatomical diagrams of the pFC regions, graphic representations of possible models, discussions of experimental methodologies and the resulting evidence from research into this phenomenon, and clinical implications of operation with each model.

This article will be included because, while it presents a more biologically grounded version of the theory, its perspective contains sufficient amounts of theoretical discussion to gain a relatively broad understanding of CC and EF. It's unique perspective also makes interesting connections between CC, emergence from neurological processing, and 'adaptive coding' to suggest a possible situation within the larger bloom's taxonomy model.

Note: Friedman, N. P., & Robbins, T. W. (2022). The role of prefrontal cortex in cognitive control and executive function. *Neuropsychopharmacology*, *47*(1), 72-89. https://doi.org/10.1038/s41386-021-01132-0

CC&EF(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article discusses cognitive control and motivation from a neuroscience perspective. The aim of the article is to investigate possible connections between motivation and control through interactions of brain systems and or subsystems. The article offers explicit definitions of cognitive control and motivation, a section on the core behavioral phenomena at play, three models representing three theoretical perspectives, an interpretation of neuroscientific findings, and a summary discussion of the work.

This article will be included because it offers the unique perspective of CC's interconnection with motivation which may offer insight into possible connections with embodied cognition, especially with respects to the reward-based models. This article also provides explicit definitions which will benefit the theory situation process.

Note: Botvinick, M., & Braver, T. (2015). Motivation and cognitive control: from behavior to neural mechanism. *Annual review of psychology*, *66*, 83–113. https://doi.org/10.1146/annurev-psych-010814-015044

CC&EF(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article specifically focuses on executive functions. The aim of the work is to discuss the development of measures of different EFs are discussed, address controversies involving the relationship between fluid intelligence, effortful control, etc., and explain how sleep, stress, and lack of exercise impair EFs. This article contains mainly theoretical discussion with some diagrams of EF concepts, and some discussions regarding the evidence presented by empirical studies.

This article will be included because of its exclusive focus on EFs and their relationship to physiological processes such as sleep and exercise. This article's commentary on fluid intelligence also suggests that there may be some connection with PC theory.

Note: Diamond A. (2013). Executive functions. *Annual review of psychology*, *64*, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

CC&EF(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the topics of Executive Functions and Metacognition. The aim of the work is to present a unifying framework that accounts for both from a developmental perspective. The work features contemporary conceptualizations of the phenomena, investigations into their internal structures, discussion on their roles in self-regulation, and insights into their neurological underpinnings. Each of these mentioned sections also offers a discussion on the evidence from empirical studies which influenced the review's positions.

This article will be included because its developmental perspectives also touch on EF and MC within the curriculum development process which ties back to the broader theme of the integrative literature review on Bloom's Taxonomy.

Note: Roebers, C. M. (2017). Executive function and metacognition: Towards a unifying framework of cognitive self-regulation. *Developmental Review, 45,* 31–51. https://doi.org/10.1016/j.dr.2017.04.001

CC&EF(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review comments on EF and Self-Regulation. The aim of the work is to argue for more communication between the cognitive, socio-psychological, and neuroscientific approaches to these phenomena. The work focuses on the following four propositions: a) broad facets of Ef's support individual's self regulatory goal-directed pursuits, b) some 'cool' cognitive concepts (working memory) may be implicated in ' hot' processes like desires and cravings, c) temporary reductions in EFs could explain situational risk factures contributing to self-regulation failures, and d) improvements in EFs may lead to better behavioral outcomes.

This review will be included because of its connection to social psychology which is a perspective not discussed in any of the previous articles.

Note: Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16*(3), 174–180. https://doi.org/10.1016/j.tics.2012.01.006

CC&EF(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the nature of executive functions. The aim of this work is to review the current research (up to 2007) on this subject. The article contains an overview on the EF model, the models connection to brain function, measures of EF, and a discussion of EFs within aging populations.

This article will be excluded because the previous articles on the topic of EF are more current and this review already has an article that focuses elusively on EFs.

Note: Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: a review of our current understanding. *Neuropsychology review*, *17*(3), 213–233. https://doi.org/10.1007/s11065-007-9040-z

CC&EF(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the topic of cognitive control. The aim is to provide a broad overview of cognitive control literature with a specific focus on the contributions provided by brain study. This article features a history of cognitive control as a theory, methodologies used for establishing the body of evidence which supports cognitive control theory, a examination of the findings, and an exploration of open questions in the field.

This review will be included because it offers an exclusive discussion on the topic of cognitive control theory and it also offers a selection of empirical studies which could be used to establish connections with some of the other theories included in this review.

Note: Gratton, G., Cooper, P., Fabiani, M., Carter, C. S., & Karayanidis, F. (2018). Dynamics of cognitive control: Theoretical bases, paradigms, and a view for the future. *Psychophysiology*, *55*(3), 10.1111/psyp.13016. https://doi.org/10.1111/psyp.13016

CC&EF(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	1	.5	1	.5	1	1	.5	.5	0	0	0	0	1	1	0	1	9

Summary of Work and Reasons for Inclusion/Exclusion

This systematic literature review covers the topic of EF as it relates to Theory of Mind. The aim of the article was to systemically review neurophysiological/ experimental studies involving EF and ToM in populations of typically developed children. The review includes an overview of theory of mind and ef as they relate to the work, description of the methodology, a survey of the studies and their findings (but not a meta-analysis of results), and finally a discussion.

This review will be included because it offers a unique perspective on the connection between EF and ToM which could be beneficial in the process of situating CC and EF within the broader Bloom's Taxonomy model. It also offers a high quality survey of empirical evidence.

Note: Economacou, D., Karousou, A., & Makris, N. (2023). The relationship between Theory of Mind and Executive Functioning in typically developing children: a systematic review. *Psychology: the Journal of the Hellenic Psychological Society*, *28*(2), 223-250. https://doi.org/10.12681/psy_hps.33349

CNoM(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of working memory from the perspective of neuroscience. The aim of this work is to review the literature on working memory to provide a state-based account of its function within the broader system of cognition. The article contains source supported explanations of working memory components' interactions with the long term memory components, and the prefrontal cortex.

This article will be included because it discusses sensorimotor recruitment which may provide a connection between embodied cognition and the act of memory. This article also provides a solid overview of some LTM components as well.

Note: D'Esposito, M., & Postle, B. R. (2015). The cognitive neuroscience of working memory. *Annual review of psychology*, *66*, 115–142. https://doi.org/10.1146/annurev-psych-010814-015031

CNoM(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of episodic memory from a constructive perspective. The aim of the work is to answer the question of why the memory involves a reconstructive process as opposed to a replay process. This article contains discussions of the constructive memory concept based on cognitive psychology and cognitive neuroscience research, investigations into false recollections in Amnesia and dementia populations, comparison of true and false recognition in typical neurologically function populations, and overlap of past recollection and future projection mechanisms.

This article will be included because it offers a unique perspective on episodic memory which may tie into topics covered by predictive coding, embodied cognition and parallel distributed processing/connectionist theories.

Note: Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: remembering the past and imagining the future. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *362*(1481), 773–786. https://doi.org/10.1098/rstb.2007.2087

CNoM(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of working memory for the perspective of emergence. The aim of this article is to argue the case that working memory is an emergent property of the interactions between the mind and brain. This article contains explanations of the standard model, criticisms of the standard model, empirical challenges to the standard model, and the alternative model of an emergent working memory.

This article will be included because the perspective of emergence may provide useful connections to the PDP/connectionist theory which could inform the structuring of the model.

Note: Postle, B. R. (2006). Working memory as an emergent property of the mind and brain. *Neuroscience*, *139*(1), 23–38. https://doi.org/10.1016/j.neuroscience.2005.06.005

CNoM(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of episodic memory. The aim of the article is to survey the changes of conceptualizing this memory system since it very beginning (up to 2002). The article features a historical account of episodic memory's development as a distinct LTM component, criticisms of the model, a case study of an individual who lost their episodic memory, and an account of functional neuro imaging memory.

This article will be included because it also provides some discussion on the distinctiveness between episodic memory and semantic memory which may tie into Integrated Information Theory discussions.

Note: Tulving, E. (2002). Episodic memory: from mind to brain. *Annual review of psychology*, *53*, 1–25. https://doi.org/10.1146/annurev.psych.53.100901.135114

CNoM(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the different components of working memory. The aim of the work is to review the empirical data which led to the development of the multi-component model of working memory. This article offers a detailed explanation of the phonological loop component, the visuospatial sketchpad, the central executive, and the episodic buffer.

This article will be included as it offers a more detailed look at the standard model of working memory than is offered in the previous articles.

Note: Repovs, G., & Baddeley, A. (2006). The multi-component model of working memory: explorations in experimental cognitive psychology. *Neuroscience*, *139*(1), 5–21. https://doi.org/10.1016/j.neuroscience.2005.12.061

CNoM(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This review covers the topic of the semantic memory as it relates to language. The aim of the article is to propose a large- scale neural model of semantic processing that argues for the inclusion of both modality-specific and supramodal representations as part of semantic memory. This article presents the main issues of semantic memory discussions, evidence for both modal specific and supramodal processing during semantic memory events, evidence that suggests embodied abstraction as the most likely model for semantic memory, and a brief presentation of the revised model.

This article will be included because of its ties to embodied cognition which is not covered in any of the previous articles.

Note: Binder, J. R., & Desai, R. H. (2011). The neurobiology of semantic memory. *Trends in cognitive sciences*, *15*(11), 527–536. https://doi.org/10.1016/j.tics.2011.10.001

CNoM(GS)7

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of memory as a whole. The aim of the article is to argue that the memory encodes information based on how that information might be activated in the future. The article offers the general framework of the argument, an explanation for how analogous activation serves as a trigger for establishing associations, a presentation on how contextual association networks coincide with the 'default network', and the implications for this type of argument regarding the fundamental purpose of memory.

This article will be included because it offers a holistic perspective on memory in general and it also offers a potential link to predictive coding theory not covered as closely by the previous included articles.

Note: Bar, M. (2009). The proactive brain: memory for predictions. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *364*(1521), 1235–1243. https://doi.org/10.1098/rstb.2008.0310

CNoM(GS)8

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the over plat between memory and imagination. The aim is to discuss the difference between the temporal and nontemporal aspects of memory and imagination. This article offers discussions of evidence for temporal and nontemporal perspectives regarding the 'default network', discussions on evidence for the differences between imagination and memory, and speculations about future research into this area.

This article will be included because of the information regarding the differences between memory and imagination which could come into play when investigating Integrated Information Theory.

Note: Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: remembering, imagining, and the brain. *Neuron*, *76*(4), 677–694. https://doi.org/10.1016/j.neuron.2012.11.001

CNoM(GS)9

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topics of event-related brain potentials and recollection memory. The aim of this work is to show how recollection memory is a continuous rather than discrete process and how ERP models support grander dual-process models of the brain. The article contains neurological evidence for ERPs, discussions on the midfrontal effect and conceptual priming, and discussions on the functional significance of old and new effects.

This article will be included because it covers the topic of implicit memory which has yet to be covered in the articles on this branch of theorization. It also draws an explicit connection between memory and dual-process theory.

Note: Rugg, M. D., & Curran, T. (2007). Event-related potentials and recognition memory. *Trends in cognitive sciences*, *11*(6), 251–257. https://doi.org/10.1016/j.tics.2007.04.004

CNoM(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of visual working memory in early development. The aim of this work is to review the literature on the subject of visual working memory in infants to gain a broader perspective of the phenomenon. The article contains descriptions of empirical studies, and graphical representations of their findings.

This article will be excluded because this topic is too narrow for the purposes of the integrative literature review. Working memory is also sufficiently covered by at least two of the articles included.

Note: Buss, A. T., Ross-Sheehy, S., & Reynolds, G. D. (2018). Visual working memory in early development: a developmental cognitive neuroscience perspective. *Journal of neurophysiology*, *120*(4), 1472–1483. https://doi.org/10.1152/jn.00087.2018

CNoM(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of how prior knowledge influences the encoding of new memory. The aim of the article is to explain how cognitive neuroscience investigations into the medial prefrontal cortex and hippocampus support the view that prior knowledge plays a vital role in encoding, consolidation, and retrieval processes. The evidence presented in this article includes behavioral evidence, neuroimaging, and evidence from developmental cognitive neuroscience.

This article will be included because it provides the unique perspective of prior knowledge's role in the encoding process which might suggest a connection between either Cognitive Control Theory or Integrated information Theory.

Note: Brod, G., Werkle-Bergner, M., & Shing, Y. L. (2013). The influence of prior knowledge on memory: a developmental cognitive neuroscience perspective. *Frontiers in behavioral neuroscience*, *7*, 139. https://doi.org/10.3389/fnbeh.2013.00139

S&CC(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of shared intentionality. The aim of the authors is to explain how humans understand intentional action and participate in activities involving shared intentionality. This article offers more of a developmental psychological account of this phenomenon as well as some evolutionary perspectives.

The article will be included because its focus on shared intentionality seem to tie into discussions on the Cognitive Control and Executive Function theory.

Note: Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *The Behavioral and brain sciences*, *28*(5), 675–691 https://doi.org/10.1017/S0140525X05000129

S&CC(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article explores the topic of motivation. The aim of the work is to explain the concept of motivation using Bandura's Social cognitive theory. The article provides a predominantly theoretically based discussion with little to no neurological reference; it covers a variety of subtopics including but not limited to social comparisons, values, and attributions.

This article will be included because it provides insight into a well known social psychological model and also features some discussion regarding diversity of culture which could be valuable for the development of the model.

Note: Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary Educational Psychology, 60,* Article 101832. https://doi.org/10.1016/j.cedpsych.2019.101832

S&CC(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		1

Summary of Work and Reasons for Inclusion/Exclusion

This article offers a neuroscience perspective on social cognition. The aim is to provide a neurological explanation as to the nature of social cognitive function. The article covers topics ranging from macroscopic neural structures to microscopic genetic factors. The article also offers some discussion on the systems-level approach to social cognition in the brain.

This article will be included because it offers a neurological explanation to some of the phenomena explored in the previous articles. Establishing neurological connections may help to build connections with the other theories.

Note: Adolphs R. (2001). The neurobiology of social cognition. *Current opinion in neurobiology*, *11*(2), 231–239. https://doi.org/10.1016/s0959-4388(00)00202-6

S&CC(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article focuses on the topics of warmth and competence in association with social cognition. The aim is to explain how these two dimensions serve as the 'universal' metric by which people measure other beings as 'friend or foe'. The article contains discussions on the primacy of warmth judgements, and differences of group characterization and individual characterization using these metrics.

This article will be included because its focus covers a unique perspective of social cognition not addressed in the previous articles.

Note: Fiske, S. T., Cuddy, A. J., & Glick, P. (2007). Universal dimensions of social cognition: warmth and competence. *Trends in cognitive sciences*, *11*(2), 77–83. https://doi.org/10.1016/j.tics.2006.11.005

S&CC(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article presents and embodied simulation account of social cognition. The aim of this article is to discuss the evidence supporting this account of social cognition in both humans and other primates. The article contains a number of descriptions regarding human and primate neurological studies involving mirror neurons and their role in embodied simulation.

This article will be included because its inclusion of embodiment draws a link to the theory of embodied cognition which may help in the redesign process.

Note: Gallese V. (2007). Before and below 'theory of mind': embodied simulation and the neural correlates of social cognition. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *362*(1480), 659–669. https://doi.org/10.1098/rstb.2006.2002

S&CC(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of the enculturation hypothesis. The aim is to critically review the controversy behind the hypotheses and present an alternative non-mentalistic view. The article contains discussions on human social cognition as a developmental system, two accounts of experiments into the enculturation hypothesis, and an alternative apprenticeship hypothesis.

This article will be included because of the 'apprenticeship hypothesis' which seeks to provide a more behavior oriented explanation that better aligns with the evidence discussed. This revised hypothesis could more effectively tie into placing social cognition theory in the broader model.

Note: Bering, J. M. (2004). A critical review of the "enculturation hypothesis": the effects of human rearing on great ape social cognition. *Animal Cognition, 7*(4), 201–212. https://doi.org/10.1007/s10071-004-0210-6

S&CC(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	1	.5	0	.5	1	1	0	.5	.5	0	0	0	1	1	0	0	7

Summary of Work and Reasons for Inclusion/Exclusion

This systemic review covers the topic of social cognition assessments across diverse populations. The aim was to review the literature involving social cognition research in the Global South, evaluate the efficacy of assessment tools used, and provide recommendations for future modification to research techniques. The article features a fairly comprehensive survey of empirical studies into the phenomenon of social cognition.

This article will be excluded because it focuses on research techniques and does not include any theoretical discussion of social cognition.

Note: Bourdage, R., Narme, P., Neeskens, R., Papma, J., & Franzen, S. (2024). An Evaluation of Cross-Cultural Adaptations of Social Cognition Testing: A Systematic Review. *Neuropsychology review*, *34*(4), 1048–1094. https://doi.org/10.1007/s11065-023-09616-0

ITT(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This opinion article covers the topic of integrated information theory. The aim of the article is to provide an overview of the subject of integrated information theory that will give readers a broad understanding of the concept and how it explains the phenomenon of consciousness. This article includes a collection of axioms that broadly define the aspects of the theory, discussions on the information capacity of consciousness, and current explanations as well as future predictions of this frameworks efficacy in modeling the phenomenon of consciousness.

This article will be included because it offers a broad perspective of the theory and possible connections to Predictive Coding.

Note: Tononi, G., Boly, M., Massimini, M., & Koch, C. (2016). Integrated information theory: from consciousness to its physical substrate. *Nature reviews. Neuroscience*, *17*(7), 450–461. https://doi.org/10.1038/nrn.2016.44

ITT(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This provisional manifesto covers the topic of integrated information theory. The aim is to present an attempt at explaining consciousness from a fundamental level. The article includes a series of phenomenological thought experiments, mathematical definitions of consciousness, and additional mathematic descriptions of quality of consciousness.

This article will be included because of its mathematical definitions of integrated information theory and its discussion of qualia.

Note: Tononi, G. (2008). Consciousness as integrated information: a provisional manifesto. *The Biological bulletin*, *215*(3), 216–242. https://doi.org/10.2307/25470707

ITT(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of Phi within Integrated Information Theory. The aim is to critique the theory's validity as a theory of consciousness by examining the limitations of the arguments for IIT, and instead presenting a counter conceptualization of IIT as a theory of proto-consciousness. The article features a critical overview of IIT, assessment of its explanatory power, and an epistemological perspective of IIT.

This article will be included because it presents an equally broad yet counter argument to the theory which helps to better define it.

Note: Cerullo, M. A. (2015). The Problem with Phi: A Critique of Integrated Information Theory. *PLoS computational biology*, *11*(9), e1004286. https://doi.org/10.1371/journal.pcbi.1004286

ITT(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of 'information' in Integrated Information Theory. The aim is to examine the definition of 'information' within the theoretical framework. The article includes an overview of the most recent iteration of IIT (3.0), a collection of perspectives on the topic of information, and argument for a consensus on a singular meaning.

This article will be included because it offers multiple perspectives through which IIT could be interpreted as well as a summary of the most recent iteration.

Note: Lombardi, O., & López, C. (2018). What Does 'Information' Mean in Integrated Information Theory?. *Entropy (Basel, Switzerland)*, *20*(12), 894. https://doi.org/10.3390/e20120894

ITT(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The Summary of Work and Reasons for Inclusion/Exclusion

This article covers integrated information theory from a critical perspective. The aim is to show how the theory misattributes the causal efficacy with which differentiated networks accomplish global information transfer with the phenomenon of consciousness. This article presents Integrated Information Theory from two perspectives, critiques the two main claims of IIT and then discusses implications for future research into consciousness.

This article will be included because of its extended discussion on the topic of Phi and how that connects to the broader IIT. This critique may also tie into Dynamical Systems Theory.

Note: Merker, B., Williford, K., & Rudrauf, D. (2021). The integrated information theory of consciousness: A case of mistaken identity. *The Behavioral and brain sciences*, *45*, e41. https://doi.org/10.1017/S0140525X21000881

ITT(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	.5	0	0	0	0	0	0	0	0	0	0	0	0	.5

Summary of Work and Reasons for Inclusion/Exclusion

This system review covers the literature regarding IIT from an artificial intelligence perspective. The aim was to conduct a survey on the body of literature involving AI to determine what are the characteristics of the studies that relate to the state of the art in IIT, and what, if any, are the relationships between IIT, AI, and cognitive systems. This article offers a list of current AI/IIT research articles, discussions regarding shared features, and describes usages of IIT in AI research.

This article will be included because it may offer connections to CC and EF theories as well as some connections to PC.

Note: Guerrero, L. E., Castillo, L. F., Arango-Lopez, J., & Moreira, F. (2023). A systematic review of integrated information theory: a perspective from artificial intelligence and the cognitive sciences. *Neural Computing and Applications*, 1-33. http://dx.doi.org/10.1007/s00521-023-08328-z

ITT(SS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the non-uniqueness problem associated with IIT. It aims to show how phi is not well defined in the sense that the value it specifies is non-unique. This article offers a mathematical approach to critiquing IIT as well as a discussion on the phenomenological implications of this result.

The article will not be included be3cause the topic of Phi has already been discussed by 2 other articles in this review.

Note: Hanson, J. R., & Walker, S. I. (2023). On the non-uniqueness problem in integrated information theory. *Neuroscience of consciousness*, *2023*(1), niad014. https://doi.org/10.1093/nc/niad014

DST(GS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This book chapter presents a broad overview of the theoretical perspective known as dynamic systems theory. The aim of the chapter is to provide the reader with a general understanding of this approach towards cognitive and behavior psychology. This chapter contains sections on the Piagetian A-not-B error, dynamic field theory and dynamic neural fields, and Non-Computational Applications of Systems Theory.

This chapter will be included because it provides a broad level description of the theory and some of its more prominent facets. The A-not-B theory may also suggest a connection with several of the theories on this list.

Note: Perone, S., & Simmering, V. R. (2017). Applications of Dynamic Systems Theory to Cognition and Development: New Frontiers. *Advances in child development and behavior*, *52*, 43–80. https://doi.org/10.1016/bs.acdb.2016.10.002

DST(GS)2

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	3

Summary of Work and Reasons for Inclusion/Exclusion

This systematic literature review covers the topic of DST as applied to psychotherapy. The aim of the article is to survey the literature within the field of psychotherapy that involves DST theories within empirical studies. The article contains information on the current state of DST theorization as applied to empirical and mathematical in the field of psychotherapy.

This review will be excluded because it doesn't include enough broad level discussion of DST theory.

Note: Klocek, A., Premus, J., & Řiháček, T. (2024). Applying dynamic systems theory and complexity theory methods in psychotherapy research: A systematic literature review. *Psychotherapy research : journal of the Society for Psychotherapy Research*, *34*(6), 828–844. https://doi.org/10.1080/10503307.2023.2252169

DST(GS)3

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of a Dynamic System Theory approach to Dynamic Field Theory. The aim of the article is to demonstrate the explanatory power of DST in several cognitive-level processes such as object permanence, naming hierarchical categories, and inferring intent. The article includes an overview of Dynamic Systems Theory, the application of the theory to A-not-B experimentation results, generalization of names for categories, and using space to infer reference, and discussions on conceptualizing cognition through emergence.

This article will be included because it offers examples of how this theory can be applicated in a wide array of cognitive explorations, which seems to situate it as a theory that operates at a broader level.

Note: Samuelson, L. K., Jenkins, G. W., & Spencer, J. P. (2015). Grounding cognitive-level processes in behavior: The view from dynamic systems theory. *Topics in Cognitive Science, 7*(2), 191–205. https://doi.org/10.1111/tops.12129

DST(GS)4

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of DST and Vygotsky's Zone of Proximal Development. The aim of this article is to explain the theory of ZPD through a dynamic systems theory perspective. This article contains a dialectical discussion of the two theories, and the ZPD reinterpretation as an emergent system.

This article will be included because it offers a unique connection between DST and a well known Social Cognition Theory, which may influence the redesign of Bloom's Taxonomy.

Note: Karimi-Aghdam, S. (2017). Zone of proximal development (ZPD) as an emergent system: A dynamic systems theory perspective. *Integrative Psychological & Behavioral Science, 51*(1), 76–93. https://doi.org/10.1007/s12124-016-9359-1

DST(GS)5

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total

	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the role of DST in developmental psychology. The aim is to argue for grand theorization through the context of Dynamic System Theory. This article contains discussions of the use of metaphor as a means of bridging theories and phenomenon, three principles to engaging with dynamic systems theory in psychology, and a narrative exploration of infants learning to reach.

This article will be included because its perspective on dynamic systems as grand theories provides a useful perspective to guide the redesign process.

Note: Thelen, E. (2005). Dynamic Systems Theory and the Complexity of Change. *Psychoanalytic Dialogues, 15*(2), 255–283. https://doi.org/10.1080/10481881509348831

DST(GS)6

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of Complex Dynamic Systems Theory as applied to Second Language Acquisition. The aim of this article is to discuss the problems of description, prediction, and generalization in a CDST, and offer a possible solution. This article contains philosophical inquiry into the topic of DST as well as DST's implications within the broader theoretical landscape.

This article will be included because it offers a unique examination of DST through a philosophical lens which isn't provided by the previous articles.

Note: Pallotti, G. (2022). Cratylus' silence: On the philosophy and methodology of Complex Dynamic Systems Theory in SLA. *Second Language Research*, *38*(3), 689-701. https://doi.org/10.1177/0267658321992451

DST(SS)1

AMSTAR 2 Scoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of Work and Reasons for Inclusion/Exclusion

This article covers the topic of antirepresentationalism in cognition. The aim of the paper is to argue for a dynamicism approach to cognition built on the rejection of the information processing paradigm which dominates theorization in cognitive psychology. The article contains information on the Dynamic Field Approach, and how it can offer a bridge between representationalist and antirepresentationalist theorization of cognition.

This article will be included because its discussion of Dynamic Field Approach adds to the conceptualization of DST which will help in the redesign process.

Note: Garzón, F.C. (2008). Towards a General Theory of Antirepresentationalism. *The British Journal for the Philosophy of Science, 59*, 259 - 292. http://dx.doi.org/10.1093/bjps/axl007

Appendix C.

Synthesis

Note: The following two procedures were used to search for alignments of themes and concepts. The first procedure was used to look for the theme or concept "reference" from within the theoretical category. The second procedure was used to search for the term as it occurred outside the source record, both within the theoretical category and across the theoretical categories.

1. Reference Search
    a. Identify the article using the article reference number (#).
    b. Select the theme or concept from the article (i.e. Embodiment)
        i. Consolidate theme to key phase.
    c. Extract quotation mentioning the concept.

2. Referenced Search
    a. Cross-reference theme or concept with outside sources
        i. If using PDF documents, use the theme or concept title in the search function as key words or key phrases.
            1. Begin by using full term, then modify by deleting portions of the search term. (Embodiment – Embodi – Embod).
        ii. Record reference and page number if concept is articulated.

The article reference numbers are the Unique Identifiers from Appendix B.

Embodied Cognition			
Article Ref #	Theme or Concept – "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
EC(GS)1	**Embodiment** – "…Embodiment is the surprisingly radical hypothesis that the brain is not the sole cognitive resource we have available to us to solve problems. Our bodies and their perceptually guided motions through the world do much of the work required to achieve our goals, replacing the need for complex internal mental representations. This simple fact utterly changes our idea of what "cognition" involves, and thus embodiment is not simply another factor acting on an otherwise disembodied cognitive processes…" (p.1)	EC(GS)2 (pg.625) EC(GS)3 (pg. 124) EC(GS)5 (pg.931)	PC&BB(GS)6 (pg. 902) PC&BB(SS)2 (pg.235) DPT(SS)2 (pg.955) CL(GS)4 (pg. 286) CNoM(GS)6 (pg. 527) S&CC(GS)5 (pg. 659) DST(GS)5 (pg.262) DST(SS)1 (pg. 11)
EC(GS) 2	**Situated Cognition** - "…Cognitive activity takes place in the context of a real-world environment, and it inherently involves perception and action…" (pg. 626)	EC(GS)1 (pg.5) EC(GS)3 (pg.109)	CNoM(GS)6 (pg. 527) DST(GS)4 (pg.81) DST(SS)1 (pg. 21)
EC(GS) 2	**Time Pressured or Real-Time Cognition -** "…We are "mind on the hoof"… and cognition must be understood in terms of how it functions under the pressures of real-time interaction with the environment…" (pg. 626)	EG(GS)1 (pg.3) EC(SS) (pg.2)	PC&BB(SS)1 (pg. 23) CNN(GS)3 (pg. 25) CNN(GS)6 (pg. 354) CL(GS)5 (pg. 511) CL(SS)1 (pg.9) CC&EF(GS)1 (pg. 84) CNoM(GS)5 (pg. 7) DST(GS)1 (pg. 50) DST(SS)1 (pg. 11)
EC(GS) 2	**Perception - Action Cognition** - "…The function of the mind is to guide action, and cognitive mechanisms such as perception and memory must be understood in terms of their ultimate contribution to situation-appropriate behavior. (pg. 626)	EC(GS)3 (pg.99) EC(SS)2 (pg.8)	PC&BB(SS)1 (pg.35) PC&BB(SS)2 (pg.226) S&CC(GS)1 (pg. 688)
EC(GS) 2	**Off-line but On-line Cognition -** "..Even when decoupled from the environment, the activity of the mind is grounded in mechanisms that evolved for interaction with the environment—that is, mechanisms of sensory processing and motor control…" (pg. 626)	EC(SS)5 (pg.67)	CNN(GS)3 (pg.25) S&CC(GS)1 (pg. 684) DST(SS)1 (pg. 8)

EC(GS)6	**Disembodied Cognition –** "…This is problematic because, although it is not difficult to imagine how embodiment might help us acquire concrete concepts, it is difficult to see how it can be anything but a hindrance with abstract concepts such as DEMOCRACY, ELECTRON, ENTROPY, JUSTICE, NUMBER, PATIENCE, and TRUTH. Representations grounded in sensorimotor systems do not seem to be well suited to representing abstract intentional contents. For this reason, abstract concepts remain a critical issue for embodied cognition…(pg.4)		CNoM(GS) (pg. 530) IIT(GS)5 (pg.21) DST(GS)5 (pg. 271)
EC(SS)5	**Embedded Cognition – "…**Embedded Cognition amounts to the idea that cognition is afforded and constrained by ongoing interactions between body and environment, emphasizing an intimate relationship between external artifacts and cognitive processes…" (pg.53)	EC(GS)2 (pg.11) EC(GS5) (pg.931)	PC&BB(SS)2 (pg. 234) CNN(GS)4 (pg. 398) DPT(GS)4 (pg336) CL(GS)1 (pg.491) CL(GS)5 (pg.518) S&CC(GS)5 (pg..662) DST(SS)1 (pg.27)

Predictive Coding and Bayesian Brain			
Article Ref # (Source)	Theme or Concept – "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
PC&BB(GS)1	**Predictive Coding** – "…Predictive coding is based on the simple but powerful idea that instead of representing the input directly, it is often preferable to represent the prediction error, the difference (or sometimes the ratio) between a sensory input and a prediction…" (pg 219)	PC&BB(GS)2 (pg.4) PC&BB(GS)3 (pg.3) PC&BB(GS)5 (pg.580)	CNN(GS)1 (pg. 66) CC&EF(GS)1 (pg. 79) IIT(GS)5 (pg. 54)
PC&BB(GS)2	**Active Inference – "…**Active inference models go a step beyond predictive coding to emphasize that the brain does not simply predict sensory input passively. Instead, it predicts what it will observe if it chooses to act in one way or another…"(pg.4)	PC&BB(GS)6 (pg. 907) PC&BB(SS)1 (pg.35) PC&BB(SS)2 (pg. 231) PC&BB(SS)4 (pg. 147)	CNN(GS)1 (pg. 66)
PC&BB(GS)3	**Free-Energy Minimization** – "…The 'free-energy' itself, that the brain is pictured to minimize, is a measure derived from information theory; in the context of a brain's generative model interacting with the external world, free-energy is equivalent to a weighted summation of squared prediction-errors…" (pg. 3)	PC&BB(SS)1 (pg. 7) PC&BB(SS)2 (pg.231) PC&BB(SS)4 (pg. 147)	IIT(SS)1 (pg. 20)
PC&BB(GS)4	**Repetition Suppression/Redundancy Reduction** – "…One of the most robust experience dependent adjustments of neural functions is RS: the repetition (or prolonged prior presentation) of a given stimulus leads to the rapid reduction of the related neural responses…"(pg.113)	PC&BB(GS)1 (pg. 222) PC&BB(GS)5 (pg.580) PC&BB(SS)1 (pg. 4)	CNoM(GS)8 (pg. 685) DST(GS)3 (pg. 200)
PC&BB(GS)6	**Embodied Predictive Coding –** "…Embodied predictive coding extends the standard predictive coding scheme by incorporating interoceptive information and the perception of the physiological condition of the body…" (pg. 904)		
PC&BB(SS)2	**Enactive Inference** – "…Our enactive interpretation of active inference – what might be called enactive inference– follows what		

	has been called the pragmatic turn in cognitive science (Engel, Friston, & Kragic, 2016). In cognitive science, this is the move away from a view of cognition as the rule-governed manipulation of internal (often symbolic) representations, to a view of cognition as being essentially action-oriented, and therefore premised on the selection of adequate forms of situationally appropriate action…"(pg. 226)		
PC&BB(SS)4	**Bayesian Brain / Inference– "…**The basis of the Bayesian Brain Hypothesis …is the idea of perception as a process of unconscious probabilistic inference about the cause of the incoming neural signals. For example, when we see a movement in a wood with our peripheral vision, our Bayesian Brain behaves as a probabilistic *Inference Machine* that represents and updates the spatial location not as a set of three coordinates, but as a *conditional probabilityy density function* of the coordinates…"(pg.	PC&BB(GS)1 (pg. 219-220) PC&BB(GS)4 (pg. 114) PC&BB(SS)1 (pg.7)	CNN(GS)1 (pg. 41) CNN(GS)5 (pg.220)

Connectionism and Neural Networks			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
CNN(GS)1	**Connectionism – "…**Connectionism starts with the following inspiration from neural systems: computations will be carried out by a set of simple processing units operating in parallel and affecting each other's activation states via a network of weighted connections…"(pg.32)	CNN(GS)5 (pg.222)	DPT(GS)5 (pg.919) DST(SS)1 (pg. 8)
CNN(GS)1	**Parallel Distributed Processing –** "…The second idea is that the computation of a perceptual representation of the current input (in this case, a word) involves the simultaneous and mutual influence of representations at multiple levels of abstraction– this is a core idea of parallel distributed processing…." (pg.42)	CNN(GS)2 (pg. 398)	EC(GS)1 (pg.2-3) CL(GS)1 (pg.494) CC&EF(SS)1 (pg. 4-5) CNoM(GS)2 (pg. 774) CNoM(GS)5 (pg.6) IIT(GS)5 (pg.8)
CNN(GS)3	**Fuzziness** – "...The evolving neuro-fuzzy systems developed these ideas further, where instead of training a fixed connectionist structure, the structure and its functionality were evolving from incoming data, often in an on-line, one-pass learning mode…" (pg. 25)		CC&EF(GS)3 pg. 146
CNN(GS)4	**Global Workspace Theory – "…**A crucial feature of these models is that they work by biased competition… The basic assumption is that the winning coalition of neurons determines conscious experience at a given moment…" (pg. 398)		PC&BB(SS)1 (pg. 42) IIT(GS)3 (pg. 9) IIT(SS)1 (pg.18)
CNN(GS)4	**Global Constraint Satisfaction** -"…The idea is that a network with recurrent connections arrives at an interpretation of a given input by settling into a stable state…" (pg.401)		IIT(GS)5 (pg.8) DST(GS)4 (pg.81)
CNN(GS)5	**Emergence –"…** Approaches to modeling cognition based on the idea that the structure seen in overt behavior and the patterns of change observed in behavior reflect the operation of subcognitive processes such as propagation of activation and inhibition among neurons and adjustment of strengths of connections between them…" (pg.348)	CNN(GS)1 (pg. 40)	EC(GS)1 (pg. 1) EC(GS)2 (pg. 625) DPT(GS)4 (pg. 340)

Dual Process Theory			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
DPT(GS)1	**Dual-Process –** "…The assumption by many theorists that cognitive tasks evoke two forms of processing that contribute to observed behavior…" (pg. 225)	DPT(GS)3 (pg. 97-98) DPT(GS)4 (pg. 322)	CNoM(GS)9 (pg. 251)
DPT(GS)2	**Token Thesis – "…**The TT states that the mind has a rigorous division into two distinct systems…" (pg. 214)		
DPT(GS)2	**Cognitive Kind Thesis –** "…The CKT differs by asserting that there are multiple systems in cognition that can fit either into the category of a System 1 or System 2…"(pg.214)	DPT(GS)1 (pg.225)	
DPT(GS)3	**Multiple Minds –** "…My two minds, according to context, are referred to as old and new, or as intuitive and reflective. My old, intuitive mind corresponds pretty directly with Stanovich's autonomous mind. My new, reflective mind corresponds with a combination of his algorithmic and reflective minds.."(pg.91)	DPT(GS1 (pg.230) DPT(GS)2 (pg. 220)	
DPT(SS)2	**Metacognition Theory – "…**Although lively debate surrounds defining it or even its existence, in general terms MC is the capacity to think about non-analytic and analytic processes at a higher level of cognitive reflection…"(pg. 955)	DPT(SS)3 (pg.177)	CC&EF(GS)4 (pg.32) IIT(SS)1 (pg. 3)
DPT(SS)3	**Paradox Theory –** "…Although the term 'paradox' itself designates 'numerous and varied meanings' (Lewis 2000, p. 761), we follow a well-established definition within the organizational literature, referring to paradox as contradictory yet interrelated elements that seem logical in isolation, but which are irrational, inconsistent and even absurd when appearing simultaneously, and which persist over time (Smith and Lewis 2011). Whereas the contradictory nature of paradoxes points to mutual exclusivity, the interrelated nature of paradoxes points to synergies which, when combined, trigger tensions…"(pg. 165)		DST(GS)4 (pg. 81) DST(GS)6 (Pg. 695)

Cognitive Load Theory			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
CL(GS)1	**Cognitive Load –** "…Cognitive load theory assumes that the human cognitive architecture consists of multiple memory stores, including a very limited working memory and an extensive long-term memory. Working memory is limited in capacity and in duration when dealing with novel information. It can combine, contrast or manipulate no more than four information elements at one time…" (pg. 474)	CL(GS)2 (pg. 86) CL(GS)4 (pg.261-262) CL(GS)5 (pg.513)	EC(GS)2 (pg.633) EC(SS)5 (pg.67) DPT(SS)3 (pg.170)
CL(GS)2	**Intrinsic Load – "…**Intrinsic load cannot be altered by instructional interventions without altering the task to be learned (e.g. simplification) or by the act of	CL(GS)1 (pg. 471) CL(GS)3 (pg. 57) CL(GS)4 (pg.263-264)	

	learning itself. It depends on the number of elements that must be processed simultaneously in working memory, a number which, in turn, depends on the extent of element interactivity of the materials or tasks that must be learned…" (pg. 87).		
CL(GS)2	**Extraneous Load –** "…Extraneous load may be imposed, for example, when learners must use trial and error or other weak problem-solving methods that require them to arbitrarily try out things without being given proper guidance,12 when they must integrate information sources that are distributed in place or time, or when they must search for information that is needed to complete a learning task…" (Pg. 87-88)	CL(GS)1 (pg. 471) CL(GS)3 (pg. 57) CL(GS)4 (pg.264)	
CL(GS)2	**Germane Load –** "…the working memory resources used to deal with intrinsic cognitive load, which lead to learning. For instance, learners construct schemas that deal with the interacting elements associated with intrinsic cognitive load by working on a series of tasks and abstracting away from them by identifying structural features and surface features in a process of induction or 'mindful abstraction'…" (pg.88)	CL(GS)1 (pg. 472) CL(GS)3 (pg. 73) CL(GS)4 (pg.264)	

Cognitive Control and Executive Functions			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
CC&EF(GS)2	**Cognitive Control – "…**By cognitive control, we refer to that set of superordinate functions that encode and maintain a representation of the current task—i.e., contextually relevant stimulus-response associations, action-outcome contingencies, and target states or goals—marshaling to that task subordinate functions including working, semantic, and episodic memory; perceptual attention; and action selection and inhibition…" (pg 85)	CC&EF(GS)1 (pg.72) CC&EF(GS)3 (pg. 136)	EC(GS)1 (pg.2) EC(GS)2 (pg. 634) CNN(GS) (pg.4) DPT(GS)3 (pg.92) DPT(GS)4 (pg. 333) CL(SS)2 (pg.8) CNoM(GS)1 (pg.128)
CC&EF(GS)3	**Executive Function – "…**Executive functions (EFs; also called executive control or cognitive control) refer to a family of top-down mental processes needed when you have to concentrate and pay attention, when going on automatic or relying on instinct or intuition would be ill-advised, insufficient, or impossible…" (pg.136)	CC&EF(GS)1 (pg. 72) CC&EF(GS)4 (pg.33)	CNN(GS)6 (pg. 350) CL(GS)5 (pg. 512) S&CC(GS)3 pg. 234)
CC&EF(GS)4	**Self-Regulation –** "…When taking into account cognitive/learning, social-interactive, and personality viewpoints, self-regulation frameworks consider EF as a means of enabling self-regulation in various situations. In that sense, self-regulation is defined as goal-directed behavior for a broad variety of contexts, including academic contexts, health-	CC&EF(GS)3 (pg. 152) CC&EF(GS)4 (pg.174) CC&EF(SS)2 (pg.225)	CL(GS)1 (pg. 497) CL(GS)4 (pg. 284) S&CC(GS)2 (pg. 5)

	related behavior, and social interactions…" (pg 34).		
CC&EF(SS)2	**Theory of Mind –** "…The theoretical construct of Theory of Mind (ToM) encompasses the awareness of the representational character of the other's mind or the human mind in general (Flavell, 2004)…"(pg. 223)		CNN(GS)1 (pg. 65) CNoM(GS)2 (pg. 782) CNoM(GS)7 (pg. 1238) S&CC(GS)1 (pg. 690) S&CC(GS)3 (pg. 233) DST(GS)5 (pg. 257)

Cognitive Neuroscience of Memory			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
CNoM(GS)1	**State-Based Memory – "…**In perhaps the most well-known of the state-based models, Cowan (1995) describes two distinct states in STM: a small, capacity-limited state referred to as the focus of attention (FoA) and a more expansive state referred to as the activated portion of LTM (known as activated LTM). In this model, the FoA corresponds to approximately four chunks of information that one can hold in working memory at any moment in time using top-down attentional control…"(pg. 117-118)		
CNoM(GS)1	**Sensorimotor Recruitment – "…**The basic premise of sensorimotor recruitment models of working memory is that the systems and representations engaged to perceive information can also contribute to the short-term retention of that information. An early, paradigmatic example of such models is that of attention-based rehearsal, whereby a location in space can be held in working memory via the covert allocation of attention to that location (e.g., Awh & Jonides 2001). For other domains of sensory information, such as visually perceived spatial frequency, contrast, orientation, or motion, behavioral evidence indicates that each is retained in a highly stimulus-specific manner (Magnussen 2000, Magnussen & Greenlee 1999, Zaksas et al. 2001) that is most parsimoniously explained as the persistent activation of the sensory representations themselves…" (pg. 118-119)		
CNoM(GS)2	**Constructive Episodic Memory –** "…We focus on one hypothesis concerning the origins of a constructive episodic memory: that an important function of this type of memory is to allow individuals to simulate or imagine future episodes, happenings and scenarios…" (pg. 773-774)	CNoM(GS)8 (pg. 681)	
CNoM(GS)4	**Episodic Memory – "…**Episodic memory is a recently evolved, late-developing, and early-deteriorating past-oriented memory system, more vulnerable than other memory systems to neuronal dysfunction, and probably unique to humans. It makes possible mental time travel through subjective time, from the present to the past, thus allowing one to re-experience, through autonoetic awareness, one's own previous experiences.	CNoM(GS)6 (pg. 527) CNoM(GS)8 (pg. 678)	EC(GS)2 (pg. 633) DPT(GS)3 (pg. 91)

	Its operations require, but go beyond, the semantic memory system. Retrieving information from episodic memory (remembering or conscious recollection) is contingent on the establishment of a special mental set, dubbed episodic "retrieval mode." Episodic memory is subserved by a widely distributed network of cortical and subcortical brain regions that overlaps with but also extends beyond the networks subserving other memory systems. The essence of episodic memory lies in the conjunction of three concepts—self, autonoetic awareness, and subjectively sensed time…."(pg. 5)		
CNoM(GS)5	**Multicomponent model of working memory –** "…A central executive was envisioned as a control system of limited attentional capacity that is responsible for the manipulation of information within working memory and for controlling two subsidiary storage systems: a phonological loop and a visuospatial sketchpad. The phonological loop was assumed to be responsible for the storage and maintenance of information in a phonological form, while the visuospatial sketchpad was dedicated to the storage and maintenance of visual and spatial information. Based on a number of empirical findings a fourth component, the episodic buffer, was added recently (Baddeley, 2000). The episodic bufferis assumed to be a limited capacity store that is capable of multi-dimensional coding, and that allows the binding of information to create integrated episodes…"(pg. 6-7)	CNoM(GS)1 (pg. 117)	EC(GS)2 (pg.633)
CNoM(GS)6	**Semantic Memory –** "…an individual's store of knowledge about the world. The content of semantic memory is abstracted from actual experience and is therefore said to be conceptual, that is, generalized and without reference to any specific experience. Memory for specific experiences is called episodic memory, although the content of episodic memory depends heavily on retrieval of conceptual knowledge…"(pg. 527)	CNoM(GS)4 (pg. 3) CNoM(GS)8 (pg.678)	

Social and Cultural Cognition			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
S&CC(GS)1	**Intentional Action – "…**If we want to know how people understand intentional action, we must first have a model of exactly what intentional action is. Here we propose a simple model based on control-systems principles –in which goal, action, and perceptual monitoring are all seen as components in the larger adaptive system that serves to regulate the organism's behavioral interactions with the environment. As discovered by cyberneticians such as Weiner (1948) and Ashby (1956), machines that act on their own "intelligently" all have the same basic organization		IIT(GS)5 (pg. 21)

	involving the same three components: (1) a reference value or goal toward which the system acts, (2) the ability to act in order to change the environment, and (3) the ability to perceive the environment so as to know when the state of the environment matches the reference value…"(pg.676).		
S&CC(GS)2	**Social Cognitive Theory –** "…Social cognitive theory is a psychological perspective on human functioning that emphasizes the critical role played by the social environment on motivation, learning, and self-regulation…"(pg 1).	S&CC(GS)3 (pg. 231) S&CC(GS)5 (pg.662)	EC(GS)3 (pg. 118) EC(GS)5 (pg. 931) PC&BB(GS)2 (pg. 8) DPT(GS)1 (pg. 234) DPT(GS)2 (pg. 216) DPT(GS)3 (pg.89) CL(GS)1 (pg. 495) CC&EF(GS)4 (pg.41) CNoM(GS)6 (pg. 532)
S&CC(GS)4	**Warmth and Competence –** "…According to recent theory and research in social cognition, the warmth dimension captures traits that are related to perceived intent, including friendliness, helpfulness, sincerity, trustworthiness and morality, whereas the competence dimension reflects traits that are related to perceived ability, including intelligence, skill, creativity and efficacy…"(pg. 77)		
S&CC(GS)5	**Mirror Neurons –** "…These neurons discharge not only when the monkey executes goal-related hand and/or mouth acts like grasping objects, but also when observing other individuals (monkeys or humans) executing similar actions…"(pg. 660)	S&CC(GS)3 (pg. 235)	CL(GS)4 (pg. 280)
S&CC(GS)6	**Enculturation Hypothesis – "…**Our hypothesis is that being treated intentionally by others, i.e. being enculturated into a cognitive community, is an integral part of the ontogeny of certain sociocognitive abilities, especially the ability to understand behavior intentionally…"(pg. 202)		

Integrated Information Theory			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
IIT(GS)1	**Integrated Information Theory –** "…The axioms of IIT state that every experience exists intrinsically and is structured, specific, unitary and definite. IIT then postulates that, for each essential property of experience, there must be a corresponding causal property of the PSC…"(pg. 450). (PSC=Physical Substrate of Consciousness)	IIT(GS)4 (pg.3) IIT(SS)1 (pg.17)	
IIT(GS)2	**Qualia Space –** "…Qualia space (Q) is a space where each axis represents a possible state of the complex, each point is a probability distribution of its states, and arrows between points represent the informational relationships among its elements generated by causal mechanisms (connections)…" (pg.216)	IIT(GS)3 (pg. 6)	
IIT(GS)3	**Consciousness –** "…Tononi defines integrated information as "the amount of information generated by a complex of elements,	IIT(GS)2 (pg.217, 233) IIT(GS)4 (pg. 2)	EC(GS)3 (pg.104) CNN(GS)4 (pg.399)

	above and beyond the information generated by its parts" (Tononi [3], p. 216) and states ,"The integrated information theory (IIT) of consciousness claims that, at the fundamental level, consciousness is integrated information" (Tononi [3], p. 217, italics in original). While the details of the mathematical calculation of integrated information have varied with each new version of IIT, this abstract definition of integrated information has remained unchanged…"(pg. 1)	IIT(SS)1 (pg.13)	
IIT(GS)3	**Circular Coordinated Message Theory-** "…The justification for CCMT is the self-evident property that consciousness is related to information traveling in feedback loops within a system (the principle of information circulation). The amount of information circulation in a system, Omicron (O), is calculated by taking the information circulation of the system as a whole minus the information circulation in a minimal partition and is equal to the amount of consciousness in a system (O can also be said to be consciousness)…"(pg.5)	IIT(GS)4 (pg. 15)	S&CC(GS)1 (pg. 676)
IIT(GS)4	**Shannon Information/Shannon's Theory –**"…In Shannon theory, information is transmitted from a source to a destination, where the source and the destination are systems precisely characterized in terms of their possible states with their corresponding probabilities. The information of a system is computed in terms of the probability distribution over its states, as the weighted average of the negative logarithms of the probabilities of the states. In this context, the relevant probabilistic relations between two systems are encoded in the mutual information, which is computed in terms of the probability distributions of the states of the two systems and the conditional probabilities of the states of one system given the states of the other…" (pg.5)	IIT(GS)1 (pg.457)	

Dynamic Systems Theory			
Article Ref #	Theme– "Reference"	Referenced in Theory Literature	Referenced By Other Theory Literature
DST(GS)1	**Dynamic Systems Theory –** "…Dynamic Systems Theory (DST) is a set of concepts that describe behavior as the emergent product of a self-organizing, multicomponent system evolving over time…" (pg.44)	DST(GS)3 (pg.192) DST(GS)4 (pg.77)	CNN(GS)6 (pg.351) CC&EF(GS)2 (pg. 93)
DST(GS)3	**Dynamic Neural Fields -** "…The basic building block of formal dynamic neural field (DNF) models is a field of metrically organized neurons; that is, neurons in this field are structured such that those close together have receptive fields that respond to similar feature values while those farther apart have receptive fields tuned to very different feature values…" (pg. 193)	DST(GS)1 (pg. 50)	CNN(GS)6 (pg.351)
DST(GS)1	**Self – Organization –** "…Systems organize into what are called attractor states, which are ways in which the components of a system reliably interact (e.g., crawling, walking, and running are different attractor states for locomotion). Systems are historical, which means that their organization in an attractor state in the moment biases them to revisit those attractor states at a future point in time (Spencer & Perone, 2008). These states become increasingly stable through experience, which means that they are resistant to perturbations from internal and external forces…" (pg. 46)	DST(GS)4 (pg. 81) DST(GS)5 (pg. 262)	PC&BB(SS)4 (pg.147)