Dear Editors:

Thank you for your consideration and handling of the present paper. And thank you for three thoughtful reviews. Enclosed please find the revised version of the paper, which has been revised in accordance with the reviewers' comments.

I wish to thank the reviewers for their helpful suggestions and comments. Please see the item-by-item responses below regarding my thinking on these points and the corresponding revisions.

In addition, many other revisions have been carried out throughout the paper (too many to list one-by-one).

I hope that the revision is acceptable to you. I am looking forward to hearing from you again soon.

Below, item-by-item responses are in black and preceded by “RESPONSE”.

[Show Review #1 **submitted on 11/Sep/2023**](https://neurosymbolic-ai-journal.com/paper/dual-process-theories-cognitive-architectures-and-hybrid-neural-symbolic-models?l=BKV-7HPUfR_g88iAS_bdJ-nhJS7Q_b0Xj6IuTzOVDgE)

**By *Anonymous User***
Review Details

Reviewer has chosen to be ***Anonymous***

**Overall Impression:** Average

**Content:**
**Technical Quality of the paper:** Average
**Originality of the paper:** Yes, but limited
**Adequacy of the bibliography:** Yes, but see detailed comments

**Presentation:**
**Adequacy of the abstract:** Yes
**Introduction: background and motivation:** Good
**Organization of the paper:**Satisfactory
**Level of English:** Satisfactory
**Overall presentation:** Good

**Detailed Comments:**

In this contribution, the author proposes to use computational cognitive architectures as a basis for neuro-symbolic systems, tracing back contemporary work to its origins in research done decades ago, when neuro-symbolic models were mostly referred to as a connectionist-symbolic models. A historic perspective on neuro-symbolic AI is helpful in contextualizing most recent advances, and in setting the stage for future publications in this journal.

RESPONSE: Thank you. It is indeed our goal to contextualize most recent advances and to set the stage for future progresses.

A few points, though, would require some additional attention by the author.

Minor revisions:

- There's no mention of the Standard Model of the Mind\*, a fairly recent - and relevant - proposal that falls under the scope of this paper. It'd be beneficial to broaden the set of examples of "Computational Cognitive Architectures" provided in section 4 with such framework.

RESPONSE: The Standard Model of the Mind has been added to the paper.

- p.2, mid-section: can the author make a couple of examples of "strong advocates" from both symbolic and deep-learning/neural community, who have started to see the value of neuro-symbolic AI (e.g., Yann LeCun in his 2022 white paper on "path towards autonomous machine intelligence")?

RESPONSE: Thanks for the suggestion. Such examples have now been included (e.g., LeCun, 2022).

- p.4, final paragrah: can the author clarify what he means by saying that part of the reason why two levels exist, is that "nature" has designed them as distinct so that they can work synergistically? Is the intention behind this argument to echo evolutionary theories? What would the other part of the reason be? This is admittedly not essential for the paper, but it has some interesting ramifications: primary emotions would be part of System 1 because they are functional to human's basic responses to stimuli from the environment (e.g, fast response to threats). Primary emotions would still be relevant, but only synergistically, in System 2 (e.g., according to Damasio's account of the role of emotions in rational decision-making).

RESPONSE: Some clarification has been added to make this point clearer: This point is indeed in relation to evolution of the human brain/mind. When it was said “at least in part”, we merely leave open the possibility that there may be other, additional reasons for this design (although they might even be currently unknown).

- Section 5: there seems to be an unresolved "tension" between ontology and epistemology when the notion of "level" is discussed. Clearly, cognitive-psychlogical realism implies that the "mechanisms" and the "symbols" modeled by computational cognitive architectures exist in the human mind, which would justify to design AI systems that reflect such characterisitcs. But, what exactly these representations are and those mechanisms do, in synergy, is the object of different theories, as also argued in the paper. So, would the author agree with the view that two separate levels of information processing exist in humans (ontology), although their fine-grained constitutents (representations and mechanisms) and how they work are still under investigation (epistemology)? If so - and even if not so - it would help to explicitly address such tension, and/or clarify the ambiguity.

RESPONSE: The ambiguity has been clarified: Few things in science are uncontroversial. There is a plethora of evidence that the two separate levels exist, but the point of two separate levels itself is not yet universally accepted (there are still people, existing today as well as in the 1990s, who dispute such a point --- therefore it is a set of “theories”). Furthermore, the fine-grained details (representations and mechanisms) of the two levels and how they operate exactly process-wise are clearly still under investigation (despite the fact that there have been a number of cogent theories, as mentioned in the article). There is indeed a tension between ontology and epistemology also. A note has been added to the article to clarify the points above.

- P.8: The author writes that "some issues involved in dual-process theories are more complex than often assumed", and thus - paraphrasing - we'd need fine-grained understanding through an overarching framework and computational simulations: is the author proposing here to extend an existing cognitive architecture, e.g., Clarion, or to develop a new one? Related to this point - see the request for including a mention of the Standard Model of the Mind.

RESPONSE: Either way (either enhancing existing ones or starting anew) or both. We need to explore multiple avenues for addressing these issues. A note has been added to the paper. The Standard Model of the Mind has been cited and briefly discussed in the paper.

Additional bibliographic entry + mention in the paper:

\*Laird, J. E.; Lebiere, C.; and Rosenbloom, P. S. 2017. A standard model of the mind: Toward a common computational framework across artificial intelligence, cognitive sci-
ence, neuroscience, and robotics. Ai Magazine, 38(4): 13–26

RESPONSE: Thanks for this suggestion. This entry has been added to the list of references and cited in the text.

Overall, this is a potentially good paper to introduce how computational cognitive architectures can be used as frameworks for neuro-symbolic AI models.

RESPONSE: Thank you.

[Show Review #2 **submitted on 18/Dec/2023**](https://neurosymbolic-ai-journal.com/paper/dual-process-theories-cognitive-architectures-and-hybrid-neural-symbolic-models?l=BKV-7HPUfR_g88iAS_bdJ-nhJS7Q_b0Xj6IuTzOVDgE)

**By *Anonymous User***
Review Details

Reviewer has chosen to be ***Anonymous***

**Overall Impression:** Good

**Content:**
**Technical Quality of the paper:** Good
**Originality of the paper:** Yes, but limited
**Adequacy of the bibliography:** Yes, but see detailed comments

**Presentation:**
**Adequacy of the abstract:** Yes
**Introduction: background and motivation:** Good
**Organization of the paper:**Satisfactory
**Level of English:** Satisfactory
**Overall presentation:** Good

**Detailed Comments:**

This paper discusses the relation between hybrid neuro-symbolic models, dual process theories, and cognitive architectures. The paper reviews the history of neuro-symbolic models from the perspective of exploring the space of combining neural and symbolic models. The article describes various dimensions of that space and argued for a guiding principle of cognitive plausibility. That perspective entails relating to dual process theories. The paper reviews the history of dual process theories from their philosophical underpinnings to their modern instantiations. The paper initially equates the well-known system 1/system 2 distinction with the symbolic-subsymbolic duality, but then discusses some of the finer distinctions and the more complex relationships between the two concepts. Addressing those rigorously requires the introduction of a computational framework for those processes such as cognitive architectures. This process is illustrated using the author’s Clarion hybrid architecture. The author speculates whether those interactions developed for an earlier generation of neural models still hold in the current age of deep learning models, convolutional neural networks and transformer-based chat agents. Overall, this is an interesting paper that draws together three core concepts and theories in the history of natural and artificial intelligence, but one wishes that the author had gone in further depth, perhaps using one specific example to ground the issues and demonstrate their interdependencies.

RESPONSE: Thank you very much for the positive remarks concerning this paper.

RESPONSE: Specific examples and their results and implications have been extensively discussed in prior publications (as cited in the present article itself). Thus these examples/results are not detailed in the paper but pointers to them are indeed provided instead, so as to avoid too much repetition.

[Hide Review #3 **submitted on 12/Dec/2023**](https://neurosymbolic-ai-journal.com/paper/dual-process-theories-cognitive-architectures-and-hybrid-neural-symbolic-models?l=BKV-7HPUfR_g88iAS_bdJ-nhJS7Q_b0Xj6IuTzOVDgE)

**By *Anonymous User***
Review Details

Reviewer has chosen to be ***Anonymous***

**Overall Impression:** Good

**Content:**
**Technical Quality of the paper:** Good
**Originality of the paper:** Yes
**Adequacy of the bibliography:** Yes

**Presentation:**
**Adequacy of the abstract:** Yes
**Introduction: background and motivation:** Good
**Organization of the paper:**Satisfactory
**Level of English:** Satisfactory
**Overall presentation:** Good

**Detailed Comments:**

Overall, this was an interesting position paper, especially in light of the "System 1-System 2" paradigm that has become a popular way to think about NSAI (e.g., Kautz). I think this paper is important for two reasons: (1.) it highlights that the ideas of System 1-System 2 predate Khaneman and the idea can be defined in several ways and (2.) it makes the case for cognitive models as a framework for thinking about these ideas. As a position paper, focused on brining these two ideas to the fore, it is successful.

RESPONSE: Thank you for the comments. These were indeed the goal of the paper.

That said, I do have some comments that could potentially clarify a few items.

1. The numbered summary of the Sun & Brokman book on page 3 (second full paragraph) might be better communicated in a table.

RESPONSE: It was indeed presented as a table originally. Here, however, to avoid somewhat tricky copyright issues, and to be consistent with the overall narrative here, it was presented as verbal descriptions instead. I think this also adds to clarity of the present article.

2. On page 6, the first paragraph (that starts section 4) could perhaps be re-written for clarity. In particular, the author talks about the "need" for a framework to understand relevant issues, which seems odd (normally I think of "needing" something as a necessary requirement);

RESPONSE: This has been rephrased.

also the phrase "because they are both at the same time" was a bit difficult to parse

RESPONSE: This has been fixed through rewording.

3. In section 4, the author may be interested in mentioning the recent proposed unified cognitive architecture (Laird et al, 2017) which unifies SOAR and ACT-R (<https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/2744>)

RESPONSE: This reference has been added to the paper and mentioned.

4. Space, permitting, it would have been nice to summarize more of the key dual-process results from Clarion in section 4. Personally, I would have preferred to have seen more of this in the paper.

RESPONSE: Thank you for your interest in these results from Clarion. They have been extensively discussed as well as summarized in prior publications (as cited in the present article). Thus these results are not detailed in the paper but pointers to them are provided instead (to avoid too much repetition and the consequent copyright issues).

5. In section 5, "transformers" was capitalized, not sure if this is a common convention.

RESPONSE: “Transformer” refers to either a particular neural network model or a type of neural network model. While the latter probably should not be capitalized, the former should. This has been fixed uniformly throughout this paper.