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A Network Model for Modulating Sensory Processing Sensitivity in Autism Spectrum Disorder: Epigenetics Adaptivity, and Other Factors

F. David¹, G. Kalibala², B. Pichon^{*3}, J. Treur⁴

¹Université Côte d'Azur, Nice, France. florian.david.9111@gmail.com

²King's College University of London, Faculty of Life Science & Medicine, London, United Kingdom. george.kalibala@kcl.ac.uk

³Université Savoie Mont Blanc, LISTIC, Annecy, France. blandine.pichon@univ-smb.fr

⁴Vrije Universiteit Amsterdam, Department of Computer Science, Social AI Group, Amsterdam, Netherlands



Florian David



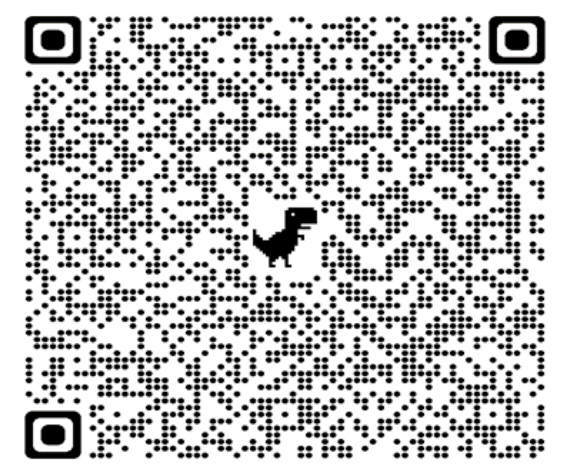
Jan Treur



Blandine Pichon



George Kalibala



SUMMARY

This paper presents a computational agent model to analyse how a specific stimulus can elicit a behavioural response in an ASD person, and how other factors may influence this response.

INTRODUCTION

The stimulus-response mechanism describes how organisms may react to stimuli (such as sunlight) with responses (such as emotions). However, the same stimulus can elicit different responses depending on various factors and contexts, such as memory and experience, (epi)genetic disposition, and environment. An agent-based adaptive dynamical system model has been designed. It focuses on the variation of these reactions in people with autism spectrum disorder (ASD), whose responses differ from those of neurotypical people.

Key references:

- Shafer, R.L. et al. (2021) Visual and somatosensory feedback mechanisms of precision manual motor control in autism spectrum disorder. *Journal of Neurodevelopmental Disorders*, 13(1). doi:10.1186/s11689-021-09381-2.
- Fakhro, K.A. (2020) Genomics of autism. *Advances in Neurobiology*, pp. 83–96.
- Loke, Y. J., Hannan, A. J., & Craig, J. M. (2015). The Role of Epigenetic Change in Autism Spectrum Disorders. *Frontiers in neurology*, 6, 107.
- Nigg, J.T. (2023). Considerations Toward an Epigenetic and Common Pathways Theory of Mental Disorder. *Journal of Psychopathology and Clinical Science* 132(3), 297–313.
- Kathusing, S., Samhan, N., Treur, J. (2023). Higher-Order Adaptive Dynamical System Modeling of the Role of Epigenetics in Anxiety Disorders. *Proc. BICA*AI'23*.

APPROACH

A scenario is presented, and the model is applied to this scenario.

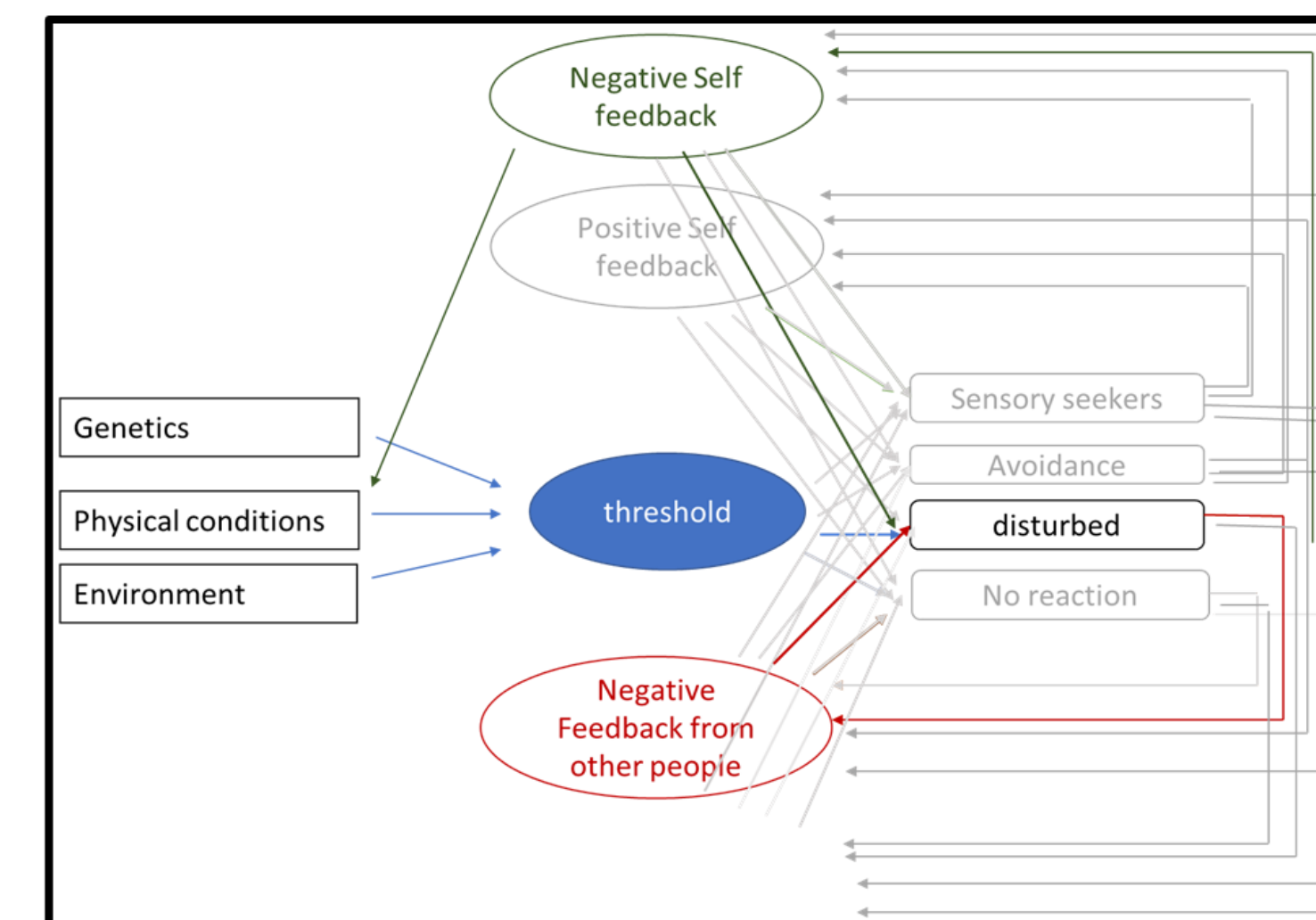


Fig. 1 Diagrams representing the reactions of a hypersensitive person with ASD exposed to the sun: she feels extremely disturbed, she has a sensory meltdown, and the surrounding people are annoyed because she starts crying

METHODS

A graphical conceptual representation displays nodes for states and arrows for connections indicating causal impacts from one state to another.

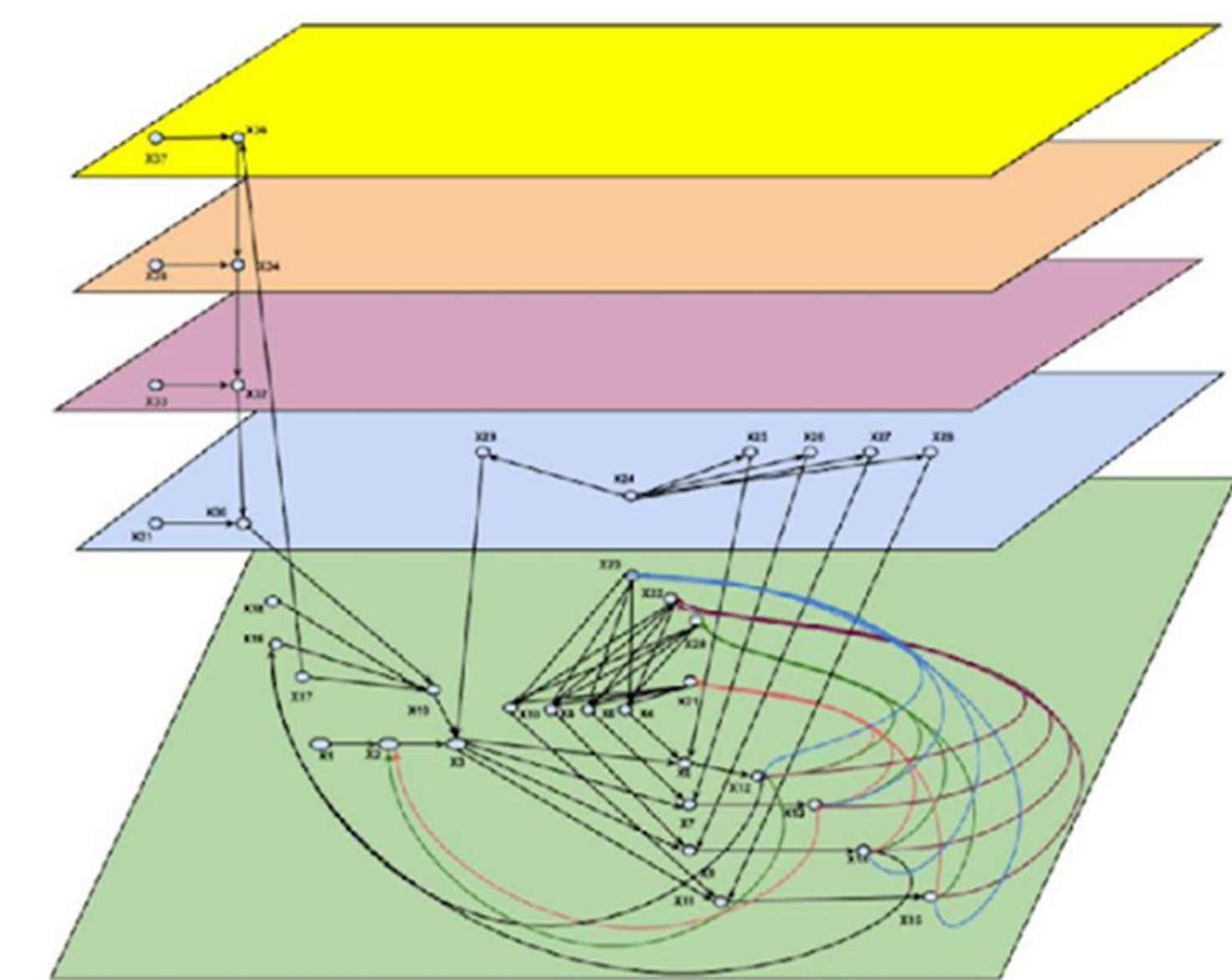


Fig 2. Graphical overview of the adaptive dynamical system model

RESULTS

On the left, we observe the reaction of a neurotypical person to sunlight (Case 1). On the right, we observe the reaction of ASD person to sunlight (Case 3).

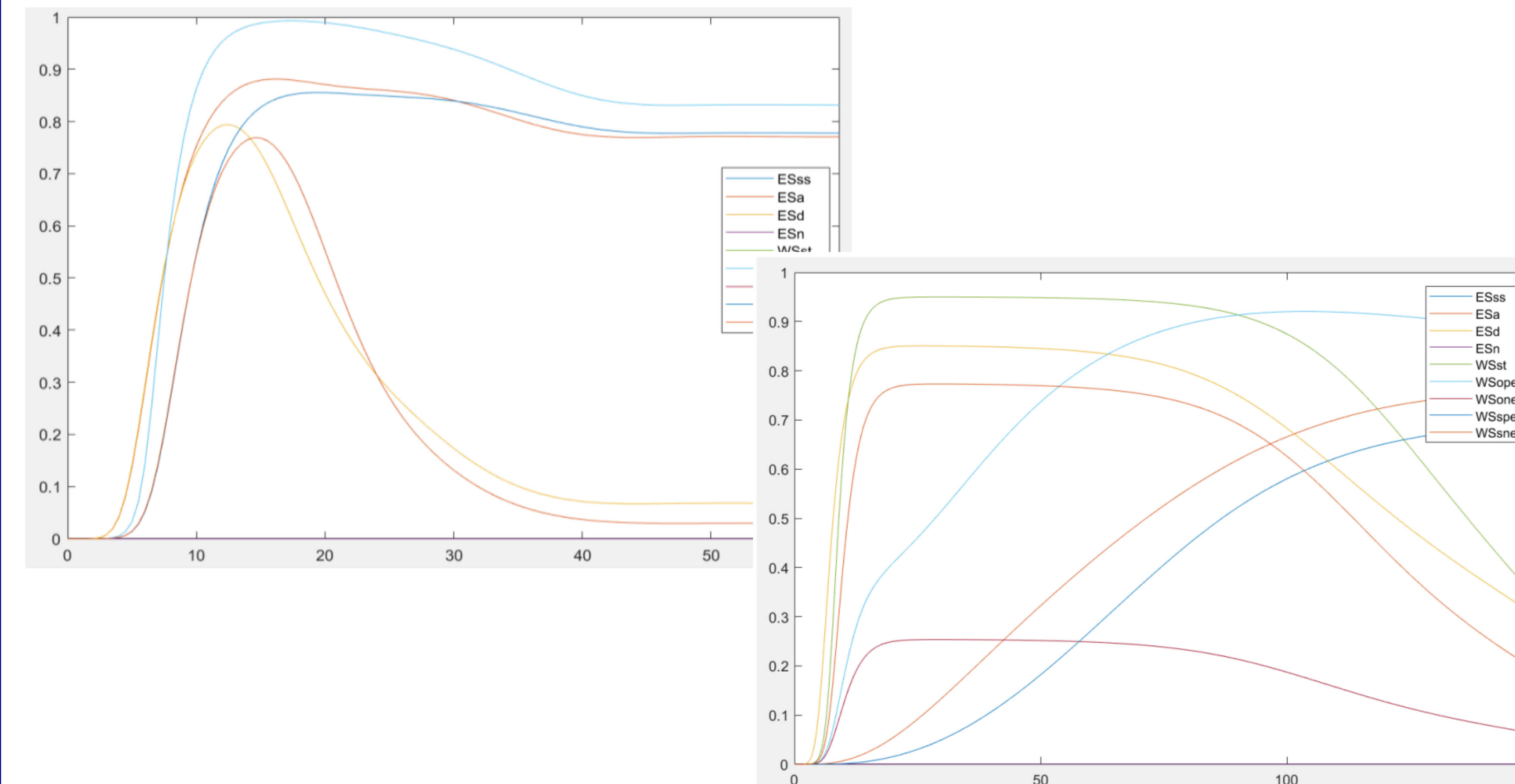


Fig 3. Simulations of a neurotypical person (left) and an ASD person (right) looking at the sun in a basic environment

ANALYSIS

When exposed to the sun, the person is uncomfortable, so her disturbance (esd) increases highly, and therefore her stress (wsst) too. Then, those two curves decrease rapidly when she starts to avoid the stimulus and her self-positive emotions (wsspe) grow. Finally, her reaction to sunlight is expected by other people because we can observe that their positive emotions (wsope) increase while their negative emotions (wsone) decrease. We can note that the sensory-seeking reaction and the lack of reaction are not typical behaviours in this situation, and for this reason, the corresponding curves (esss and esn) are constant at 0.

DISCUSSION

We have implemented a single node for the environment, but it could be interesting to discriminate more precisely the environmental factors, such as the external noises, the temperature, or the surrounding smells, which can all influence our behaviour. Similarly, the stress node can represent anxiety, tiredness, physical condition, and other specificities.

CONCLUSIONS

1. This paper introduces an adaptive network model exploring how epigenetics influences Sensory Processing Sensitivity (SPS) in individuals with Autism Spectrum Disorder (ASD) and how various factors affect their behaviour.
2. The model can be adjusted to simulate different scenarios and help predict how people with ASD might respond in various environments.
3. However, it has some simplifications, and future research will involve using real-world data from both autistic and neurotypical individuals to validate its findings.