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CLINICAL NEUROSCIENCE: 5-PHASE MULTIMODAL MODEL OF PERCEPTION AND PERCEPTUAL ERRORS

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ABSTRACT

Introduction: Currently, several models of stimulus-response perception have been theorized, but none have integrated second-person neuroscience with neuromaladaptive mechanisms, that is, those involving social interactions. ***Objective:*** To assist in the comprehensive multiscale understanding of cognitive function and behavior through clinical insight into the sequential phases of perceptual processes of the 5-phase multimodal model of perception. ***Methodology***: We synthesized a 5-phase model of perception, with a generative view of perception and second-person neuroscience, in a "Bayesian" computational method, which was guided by theoretical method and robust clinical empiricism. ***Results and Discussion***: We used the adaptation and integration of some cognitive models and presented the model based on theoretical data, combined with empirical clinical observation. ***Conclusion:*** The novel model captured nuanced patterns of functioning in dysfunctional subfunctions of perceptual neurocognition, which generate patterns of negative effects on cognition and behavior, with several neurobiological mechanisms, which were characterized as perceptual errors. Currently, this set contributes to various types of social conflicts, domestic violence, parental neglect, behavioral deviations, and addictive disorders.

Key words:neurodesadaptative, perceptual errors, cognitive model

1. Introduction

In recent years, evidence has mounted that social knowledge shapes not only how we interpret the world around us but also how we live. 1

Humans are intensely social: social interaction in all shapes and sizes is a central aspect of our existence and survival.·1

The ability to regulate perception, cognition, and behavior is a fundamental characteristic of any complex organism that allows them to successfully navigate and adapt to changing and uncertain environments.1-2

Cognitive flexibility, the readiness with which one can selectively switch between mental processes to generate appropriate behavioral responses, develops over a long period of time and is compromised in several prevalent neurodevelopmental disorders. 1-2

The brain's nature presents an emotional causality effect that helps in understanding the reason why an event arouses an emotion (elicitation), which is a neurological reaction to a stimulus, and which causes effects in the physical body.3 Organizing this flow intimately, with the observation of the quality of the aroused emotion, generates the beginning of the notion of the objective and subjective context (differentiation).1-4

Research on emotions and stress has demonstrated the difficulty of finding objective predictors of a situation that would invariably affect different people in the same way. Different people tend to react in different ways to the "same" stimulus.1-4 Individual differences in response inhibition tasks may be particularly related to this ability because if a goal is inactive or ineffective, more automatic or prepotent responses will take over, leading to poor performance on these tasks. 1-4

The things we know, both consciously (explicitly) and unconsciously (implicitly), about other people help us quickly interpret their behavior and respond appropriately, but there are situations in which our final perception of a person, object, or environment may be distorted and even misleading. 1-4

The fields of social perception and emotion perception are driven by a remarkable everyday phenomenon: human observers are able to effortlessly and automatically derive a wealth of important information from another person's visual perceptions if they have the ability to mentalize. Several models of stimulus-response perception have now been theorized, but none have integrated second-person neuroscience with the neuromaladaptive mechanisms involved in social interactions. 4-6

The proposed multimodal model expands traditional perspectives on perception by integrating neurotemporal, predictive, and social factors, offering a more comprehensive framework for the study of normal and pathological perceptual mechanisms.6

Understanding these processes may have significant clinical implications, aiding in the development of therapeutic strategies for disorders involving perceptual dysfunctions, such as autism spectrum disorder, schizophrenia, and dissociative disorders.6

2. Objective

We suggest that a generative Bayesian approach to perception provides a powerful theoretical framework for accommodating how these high-level social factors can influence low-level perceptual processes in their early stages.

To aid in the comprehensive multiscale understanding of cognitive function and behavior through clinical insight into the sequential phases of perceptual processes of the 5-phase multimodal model of perception.

To demonstrate how different subfunctions of neurocognition co-occur within individuals and how they may relate to different forms of behaviors and disorders of consciousness, which present significant unfolding in several important clinical contexts, as a true neurodysfunctional connectome.

3. Methodology

To systematically search the literature on the neurobiological bases of human perception, we searched the PubMed and Web of Science digital libraries using the terms "error prediction," "perception," "attention," "synchrony oxytocin," and "inhibitory control processing."

We reviewed neuroscience articles chosen for convenience, which presented experimental findings with clinical data from functional neuroimaging exams and which presented mechanisms that shape the perception and evaluation of people, behaviors, and socially relevant information.

4. Results and Discussion

As a result, studies that analyze performance on a single task are unable to account for the potential influence of other subfunctions. Similarly, studies that use a battery of tasks tend to treat each task as an independent measure of neurocognition, rather than capturing the interplay between neurocognitive subfunctions that occur simultaneously and are directly connected neurobiologically and clinically.7-9

According to current computational models, such as the Interactive Dynamics (ID) Model, when viewing another person's face, social and emotional categories become automatically activated, which in turn automatically activates related conceptual associations.4-6

The current Three-Stage Dynamic Brain-Cognitive Model by Huang L et al. (2024) assesses the neural correlates of action intention, using the stages of body perception, identification, and understanding of intention.6

Over the past decade, recurrent circuit models (RNMs) have been developed and widely applied by computational and cognitive neuroscientists to perceptual decisions, action selection, and value-based choice behavior.1

According to the drift-diffusion model (DDM), a 'decision variable' integrates evidence relating to two alternative choices (A and B). A decision is made when the decision variable reaches a positive (for alternative A) or negative (for alternative B) threshold. 4-9

RNM strives to identify biological mechanisms for a long but finite integration time. One plausible neural basis for a long integration time is NMDA receptor-dependent recurrent synaptic excitation. 4-9

The functional benefit of temporal integration has been demonstrated in the model by showing that performance improves when the system is allowed to integrate inputs for a longer time but eventually reaches a plateau with sufficiently long integration as the system reaches a state of attraction that represents a categorical choice. 11-13

Whereas in DDM, evidence presented at different time points is given equal weight, RNM argues that evidence available early has a greater impact on the final choice than evidence presented later and immediately before a decision is made. 10-14 Several studies of Enhanced Perceptual Functioning Models (EPFMs), as is well established, show that autistic individuals outperform the typically developing population on a variety of low-level perceptual tasks, through peaks in ability. 10-14

Senkowski D et al. have demonstrated clear differences in the cortical networks activated by multisensory motion stimuli as a consequence of the semantic relatedness (or lack thereof) of the constituent sensory elements. 10-14

All models include an implementation and simulation of an elementary reward mechanism. 11-13

The central mechanism is that provisional rules of behavior, which are encoded by groups of active neurons in the prefrontal cortex, are selected or rejected based on an evaluation by this reward signal, which may be transmitted by the midbrain dopamine neurons with which the prefrontal cortex is densely interconnected. 11–13 A central topic in cognitive science is how cognitive control is flexibly adjusted to changing environmental demands at different time scales to produce goal- and value-oriented behavior. 11–13

The functional neuroimaging (fMRI) studies have demonstrated this view through evidence that the conflict monitoring function is localized to the anterior cingulate cortex (ACC) and signals the demand for enhanced control to the PFC. 11–12 At the molecular level, the reward signal is postulated to be a neurotransmitter such as dopamine that exerts a global modulatory action on prefrontal synaptic efficacies, either through volume transmission or through targeted synaptic triads. Negative reinforcement has the effect of destabilizing the currently active rule-coding clusters; subsequently, spontaneous activity varies again from one group to another, giving the organism a chance to discover and learn a new rule.11-13 Thus, reward signals function as effective selection signals that maintain or suppress currently active prefrontal representations as a function of their current fitness.11-13

For the more complex tasks, we found that it was necessary to supplement the input.

1) Negatively Modulated Cognitive Penetrability (NMP): If perception (or a stage thereof) is cognitively influenced in a way that makes it unfit to play the role of a neutral epistemological basis by vitiating its justificatory role in grounding perceptual beliefs, perception (or a stage thereof) is impaired. 18-19

2) Positively Modulated Cognitive Penetrability (PPC): Presence of factors that facilitate the justificatory role of perception. These are cases in which prior perceptual knowledge changes the appearance of a scene, which is supposedly a case of cognitive penetrability, by affecting the features in a visual scene that become salient and are therefore selected for later processing; expertise and familiarity facilitate the emergence of certain patterns that enable or accelerate object recognition. 18-19

3) Cognitive Impenetrability: If perception (or a stage thereof) is cognitively influenced in a way that does not affect its epistemic role in justifying perceptual beliefs. 18-19

Since the cognitive penetrability of perception weakens the possibility of such data, the justifying and elaborative role of perception is altered, and it can still generate consequences in decision-making or even trigger the activation of harmful biobehaviors or unequivocal judgments, we will use the term perception errors to classify PCMN with negative unfolding. 18-19

4.1 Development

Human perception is a dynamic and hierarchical process that integrates multiple layers of neural processing, from the initial reception of sensory stimuli to the conscious construction of the perceptual experience. In the five-phase multimodal model of perception, it is proposed that perception does not occur in a linear manner but rather as an iterative and predictive mechanism in which the brain anticipates information and adjusts sensory interpretation in real time.

This process is mediated by distributed neural circuits, including interactions between the hippocampus, temporal cortex, thalamus, and prefrontal cortex, which are fundamental for the consolidation and modulation of conscious perception. The theory of Bayesian generative models suggests that the brain not only interprets external stimuli but also constantly generates predictions based on previous memories and environmental expectations.

This concept aligns with the hypothesis of active cognition, where perception results from an interaction between bottom-up stimuli (coming from the senses) and top-down processes (influenced by experience and context). Errors in this predictive mechanism can result in perceptual distortions, ranging from benign phenomena such as déjà vu, to pathological manifestations such as delusions and hallucinations in neuropsychiatric disorders. In the context of neural time, perception is not immediate but structured on different temporal scales. Studies show that temporal coding of perception occurs between 200 and 500 milliseconds and is regulated by neural oscillations in different frequency ranges.

The phenomenon of déjà vu can be interpreted as a failure in temporal synchronization between neural networks responsible for categorizing novelty and recognizing familiarity. From this perspective, the entorhinal cortex and the hippocampus play crucial roles in pattern detection, while the interaction between the thalamus and the prefrontal cortex regulates the attribution of meaning and context to the perceptual experience. In addition to temporal aspects, perception is also modulated by neurotransmitter circuits, especially dopamine, acetylcholine, and glutamate. Dopamine, involved in coding the value and relevance of stimuli, influences the brain's ability to distinguish between real and illusory events.

Dysfunction of this system can lead to hyperassociative states, in which the brain exaggerates connections between irrelevant stimuli, as occurs in psychotic disorders. Acetylcholine, which is essential for attention and synaptic plasticity, modulates the accuracy of perceptual prediction, preventing errors in the correspondence between expectation and reality.

The five-phase multimodal model of perception also incorporates the social and interactive dimension of perception, highlighting how second-person neuroscience contributes to the formation of perceptual experience. Perception is not an isolated event but rather a dynamic phenomenon that adjusts based on emotional feedback and social interactions. Perceptual processes such as categorizing facial expressions and reading the intention of others rely on neural circuits that include the medial prefrontal cortex, amygdala, and superior temporal sulcus, allowing the brain to refine its interpretation.

4.2 5-Phase Multimodal Perception Model

According to Eckstein MP et al., the ideal observer model can be modified to integrate new data on visual attention, such as the neurological constraints that limit human attention, in the same way that sequential ideal observer analysis has been used to include physiological processing components of human spatial vision.50-51 This model distinguishes two main computational spaces within the human brain: a single global workspace composed of distributed and tightly interconnected neurons with long-range axons and a set of specialized and modular perceptual, motor, memory, evaluative, and attentional processors. 1-6 In the course of task performance, workspace neurons become spontaneously co-activated, forming discrete but variable spatiotemporal patterns subject to modulation by vigilance signals, selection by reward signals, and especially by value-driven attentional capture.1-6

This model makes predictions about spatiotemporal activation patterns during brain imaging of cognitive tasks, particularly under the conditions of activation of the dorsolateral prefrontal cortex and anterior cingulate cortex, their relationship to reward mechanisms, and their specific response during elicitation processing.1-6
Matching behavior cannot be a steady state of learning when fluctuations in the input of individual sensory neurons are so large that they affect the net input to value-coding neurons.1.

This situation naturally arises when synaptic strength is sufficiently strong and excitatory and inhibitory input to value-coding neurons is balanced, and cognitive penetrations with contextual and top-down influences on early visual processes. 2-4 Studies have shown that the development of social conformity is equivalent to the principles of reinforcement learning and that adaptations to the group norm are linked to so-called prediction error signals in the ventral striatum in adapting individuals. 1-6

Based on a perceptual model focusing on elicitation mechanisms, we propose different types of cognitive penetration depending on the level of processing at which the penetration occurs and depending on where the penetrating influence comes from. 1-6

The hierarchical order of sensory integration in the human brain can be seen as a Bayesian model, with five phases of perception that were constructed with guidance from 'theory-based modeling' and clinical empiricism: Phase 1: Preperception, Phase 2: Registration Perception, Phase 3: Elaborative Perception, Phase 4: Self-observation and CC, and Phase 5: Execution Perception. 1-6

Figure 1. Multimodal 5-Phase Model of Perception
Working Memory
↓ ↓ ↓ ↓
1Pre-Perception➔2 Perception ➔3Self-Perception➔4 Perception Elaborative ➔5Recording Executive Observation
↓ ↓ ↓ ↓ ↓
Cognitive Penetrability with positive or negative modulation
Phase 1 Phase 2 Phase 3 Phase 4 Phase 5
↓ ↓ ↓ ↓ ↓
Pre-Initial Vision Reasoning Intelligence Cue Making Identification Reflection Emotional Decision Synchronization Coding Choice Agency Judgment Covert Attention Attention Notion Action Processing Comprehension Discourse

4.2.1 Phase 1: Pre-perception

It is important to emphasize that the modulatory effect of cooperative social interaction on asymmetric phase synchrony (coherence between different brain regions) was restricted to interbrain (rather than intrabrain) measurements, which highlights the importance of extending neurobiological investigations of social interaction to interacting brains.11-12

Liu B et al. demonstrated the influence of temporal synchrony on multisensory integration, which occurs independently of the synchrony between **a**uditory and visual inputs.11-12

4.2.1.1 Interpersonal Synchrony

Infant stimuli elicit broad neural (cognitive) and behavioral responses in human adults, and this massive allocation of resources attests to the evolutionary significance of primary attachment; however, many of these responses generate dysfunctional states through the activation of cognitive and behavioral schemas.11-12

Physiological interpersonal synchrony has a clear influence on hormonal states and the autonomic nervous system. 11-12

Research on brain synchrony is assessed using intersubject correlation (ISC) metrics, which analyze the correspondence in neural activations between individuals when they are exposed to the same dynamic stimulus, such as a date.11-12

Synchrony is linked to the moment-to-moment classification of valence that can modulate positively or negatively. Neural synchrony explores the brain's preprogrammed response to unfolding events and identifies regions that signal this similarity between brains, which have signaling mechanisms, and spontaneous activation between pairs, showing the similarity in neural response. 11-12 Studies involving naturalistic stimuli in which intersubject synchrony (ISS) is measured while participants are exposed to context-specific parental stimuli provide a meaningful window into perceptual and cognitive processes. 11-12

Research in which participants watch films evokes confidence and gating activity in several brain regions that exhibit a hierarchy of information processing, such as the primary and secondary auditory and visual cortices, multisensory areas, and language areas in the prefrontal, temporal, and parietal association cortices. 11-12

Other areas that show interbrain synchrony include primary sensory regions, higher-order association areas such as the superior temporal sulcus (STS), and prefrontal regions. Low-level auditory, visual, and somatosensory regions also showed greater synchrony with the social context.1-12

Interpersonal neural synchrony can be targeted through hyperscanning neurofeedback and indirectly through behavioral interventions or physiological peripheral biofeedback. 11-12

Studies have demonstrated the delimitation of pre-registered nodes of the parental care network (PCN), which integrates subcortical structures that support motherhood with cortical areas related to simulation, mentalization, and emotional regulation. 11-12

They also showed that widespread cross-brain synchrony is involved in both the PCN and the neuroaxis, from the primary sensory/somatosensory areas, through the insular-cingulate regions, to the temporal and prefrontal cortices. 11-12

Social context shows important concordance in cross-brain synchrony, with striatal PCNs, parahippocampal gyrus, superior temporal sulcus, ACC, and PFC. 11-12

Studies have shown that social attachment stimuli, representing evolutionarily salient universal cues that do not require verbal narrative, trigger substantial brain concordance and suggest that the mother-infant bond may function to synchronize brains in a unified experience, as well as strengthen interpersonal bonds. 11-12

The neural mechanisms that support social interaction differ from those involved in social observation and highlight a role for the so-called "mentalizing network." 11-14 The similarity of neural patterns activated in the default mode network (DMN) shows significant overlap with the mentalizing network. Currently, evidence shows that specific cues involved in attachment relationships activated regions of the PCN in studies that presented parents with stimuli of their own baby compared to an unfamiliar baby, as well as in non-own babies, and concluded that any similar cue activates parental networks, which individually present an internal working model of attachment that follows the confirmed caregiver role.

4.2.1.2 Pre-Calling

Studies have shown that several precuing attentional effects directly modulate early visual processing itself, both because signatures of these effects are found in early vision and because these effects involve cognition. 15-19 The effect of being observed by another person goes beyond mere social facilitation and has been described as an audience effect. Being observed is one of the most basic and simple social interactions. Several studies have shown how an audience can induce the belief that one is being observed and cause behavioral and cognitive changes through underlying brain activity. 15-19

Receiving a signal can benefit the recipient in the sense that he or she has gained information about the social world, even if this information is negatively valenced (learning that another person is hostile). 15-19

However, we recognize that there are circumstances in which receiving additional social information through a signal can have negative consequences for the recipient if the sender is lying and using the signal to manipulate the recipient. 15–19

Overall, the social signaling framework takes an incremental approach to understanding social interactions in terms of signal exchanges between senders and receivers. 15–19

Social signaling and synchrony build on the basic premise of second-person neuroscience that engaging in social interactions involves additional neurocognitive processes and social dynamics compared to not being in an interaction and present a concrete biobehavioral framework for establishing testable hypotheses in the context of two-person interactions. 15–19

Pre-cueing may increase the value of some parameters and decrease that of others, and this causes some inputs to take priority in terms of subsequent processing, but this does not mean that initial vision does not retrieve all the information in the visual scene. 15–19

In the case of object/feature pre-cueing, though, anticipatory effects increase the activity of neurons that respond preferentially to the pre-cued object or feature, increasing the likelihood that they will eventually be selected for further processing. 15-19 In precuing, processing during stimulus viewing in early vision relies solely on bottom-up processing or restricted top-down and lateral processing within visual areas. This is distinct from the role of attentional control during visual processing that involves top-down attentional control of perceptual input. 15-19

If the precue does not affect the information retrieved from the visual scene, the relevant cognitive states involved do not affect the selection of the "evidence" or the information against which hypotheses regarding object identity will be tested in late vision.15-19

Carryover effects from the enhanced initial activation of relevant feature-sensitive areas due to precuing, or from the anticipatory effect of precuing.15-19 The effects of prestimulus or precue feature attention may act as a preparatory activity to increase stimulus-evoked potentials, and hence sensitivity to the cued feature, within feature-sensitive areas, or they may act to modulate stimulus-locked transients by suppressing neural noise. In either case, they make target detection easier, less costly, and faster. Thus, preparatory activity that occurs through pre-cues that rely on feature/object-based attention increases the baseline firing rate of neurons that prefer the attended stimulus that the participant is instructed to attend to or for which a cue is presented prior to stimulus presentation.15-19

These effects generalize from V1 and V2 to higher levels of perceptual processing. Research suggests that objects in a visual scene are individuated and sometimes categorized by early vision regardless of whether they are targets or non-targets or cued or uncued, meaning that early vision retrieves the necessary information and individuates all objects in a visual scene despite the modulation of pre-stimulus activity due to object/feature-based pre-cueing.15-19

There are several interpretations of the effects of precueing on neural activity in occipital areas of the brain. They may act to increase the baseline firing rates of neurons that encode pre-cued stimuli; these are cases of gain modulation. 15-19

4.2.2 Phase 2: Register Perception

This cognitive ability is closely correlated with spatial perception, which is formed by the end result of the organization of the integration of several errors after stimuli, which aim to assist in the understanding of consciousness in a general panorama of the relationships and forms of the external environment.20-23 It may seem like a split-second phenomenon, but deliberating about which emotions we perceive unfolds in several stages of decision-making processing. 20-23Neurocognitive models of general perception postulate that our brain first extracts sensory information about the world, then integrates this data into a percept, and finally interprets it.20-23

Furthermore, the left amygdala was responsive in all classes of decision-making paradigms, regardless of task-related demands. Bilateral brain processes for nonverbal decisions, left brain processes for verbal decisions.20-23 Regulation occurs when incoming sensory information is made available to higher-order brain regions and compared to a mental model. 20-23

Ventral streams: This mental model consists of semantic categorical representations, such as a prototype of a stimulus or how a familiar face involuntarily stimulates. 20-23

Dorsal streams, the mental model consists of visuomotor and audiomotor sequences potentially stored in our procedural memory, demonstrates how emotional expressions and emotional statements evolve over time. 20-23 These models allow us to perceive and discriminate the actions of other individuals, including facial movements and speech. A later involvement in the process of emotional perception concerns emotional categorization or verbal labeling.20-23 The involvement of the dmPFC in this specific decision-making process suggests that facial, bodily, and vocal emotional expressions are not only proxies for mental states, but also that perceivers spontaneously infer mental traits and states (beliefs, desire, intention) that are integrated into the emotional evaluation.20-23 In addition to the frontal brain structures targeted by the ventral and dorsal processing streams, other brain structures that do not belong exclusively to either processing stream also contribute to perceptual decisions about emotions.20-23 The amygdala is the structure that works concomitantly with sensory cortices and higher-order cortices to label incoming sensory information with contextual relevance and subsequently detect this relevance in the next encounter with that stimulus.

The pre-cueing mechanism sets the values of some parameters of the transformation rules in feed forward processing, and thus defines parameters that highlight some information in the visual scene, increasing the activation of neurons that encode this information, functioning as true selection filters.17-23

4.2.2.1 Initial Vision

The representations formed in the initial vision include information about spatiotemporal and surface properties, the shape of the object as seen by the observer, color, texture, orientation, movement, and affordances of objects, in addition to representations of objects as solid and limited entities that persist in space and time. 24-29 The hippocampus receives inputs from the perirhinal cortex, which is itself the site of several information inputs, such as visual, olfactory, and somatosensory stimuli, all involved in object recognition. 24-29

The onset of a visual stimulus initiates the encoding and construction of the percept. The useful information is encoded by a set of neurons in the visual cortex. 24-29 The stream of momentary evidence comes from neurons in the visual cortex, concentrated in the middle temporal region of the brain. Other neurons, which reside in the association cortex, represent the accumulation of this momentary evidence.24-29 Early visual processes retrieve from the environment the information that will eventually allow a visual scene to be perceived with the greatest possible precision so that these objects are individuated regardless of whether they are targets or nontargets. 24-29

During visual processing, cognitively guided selective attentional control selects for later processing a specific feature or object in a visual scene by triggering the firing rates of neurons that have a stimulus-evoked response to a particular stimulus. In this context, top-down signals modulate perceptual processing during stimulus viewing. 24-29

4.2.2.2 PerceptorNotion

Internal consciousness is considered the fundamental unit of consciousness, necessary for its generation even in isolation, considered when the generation of a conscious "perception" or "episode" occurs, however, it is seen as a discrete neural event in space and time.29-33

After primary processing in the occipital lobes, visual information is transmitted to the posterior parietal lobes (PPLs) through the dorsal stream and to the inferior temporal lobes through the ventral stream. 29-33

Many brain areas and activities are involved in conscious experience, perception, identification, judgment, and sense of reality, in a distributed manner, constructing the different levels of consciousness in the hierarchy that we use for the primary survival functionality.29-33

A subjective state of sensations, feelings, and thoughts that exhibit continuity over time and can be externally or internally oriented, transitioning from one state of consciousness to another.29-33

Such a hierarchical view of the survival functional perspective implies that consciousness is classified in the sense that there are different degrees of consciousness, and that we classify its lived reality according to the underlying neuronal network in activity, which allows us to begin to have an objective clinical notion.29-33 Statistical differences in the physical properties of different subsets of images are detected very early by the visual system before any top-down semantic involvement, as evidenced by the elicitation of an early deflection in the differential between ERPs of target and non-target animals at about 98 ms (lobe occipital) and 120 ms (frontal lobe). 29-33 The associations that are built, through learning, in early visual circuits reflect the value distribution of the properties of environmental scenes. 29-33

The perceptual stages are necessary to compensate for the intrinsic delays that our sensory and motor systems have in processing incoming information and generating appropriate behavioral responses. 29-33

4.2.2.3 Attention

In everyday life, the visual system is constantly stimulated with information about different objects, and the attention network captures what is needed to select a subset of this information for subsequent processing. 29-33

Attention is the mechanism that allows this selection to occur, but there are competing theories about what guides this selection. One type of attentional selection is object-based: attention is directed to objects that are defined on the basis of pre-attentional segmentation according to basic grouping principles.29-38

According to Posner et al., spatially-based attention is the direction of attention to specific locations and objects, and the parietal lobes are central to visual attention and spatial processing.29-38

According to a systematic review, the ventral stream, which extends from the early visual areas through the inferotemporal cortex, is responsible for processing objects, while the dorsal stream, which extends from the early visual areas through the parietal cortex, is responsible for processing information about space.29-38

In this process, the nervous system is able to maintain selective contact with the information that arrives through the sensory organs, directing attention to those that are behaviorally relevant and ensuring effective interaction as a means.29-38

In this way, attention is related to the preferential processing of certain sensory information.29-38

What we perceive depends directly on where we are directing our attention. The act of paying attention, regardless of the sensory modality, increases perceptual sensitivity for discriminating the target, in addition to reducing interference caused by distracting stimuli.29-38

The focus of these models was to determine the moment in which stimuli are selected. Thus, early selection theories are divided from late selection theories.29-38 The first determines that stimuli do not need to be fully analyzed in order to be selected. Late selection theories indicate that stimuli arriving through sensory pathways receive a prior analysis of characteristics and meanings and, from there, stimuli that will receive more in-depth processing by cortical areas are selected.29-38

The attentional system acts as a filter that "opens" for information to be attended to and "closes" for ignored information. Thus, unattended stimuli are rejected in the initial stages of information processing.

In a study of selective attention in the visual and auditory modalities using positron emission tomography (PET), it was shown that the mechanisms of selective attention depend on the modality of the sensory information to be processed. 29-38 Visual selective attention activates the regions of the visual association cortex, parietal and prefrontal. Auditory selective attention active tes the auditory cortex, inferior parietal, prefrontal, and anterior cingulate. 29-38 Involuntary attention is elicited by the characteristics of the stimuli; that is, it occurs in the face of unexpected events in the environment, and the individual is not the agent of choosing his or her attention. 29-38 But expectation and attention are different. Attention, in contrast, is thought of as a mechanism that allows someone to focus or zoom in on what is relevant to their purposes. 29-38

There is empirical evidence that stimulus probability and task relevance are manipulated independently, suggesting that expectations are decoupled from feature-based attention.29-38 Therefore, the effects of attention and expectation should be treated differently. Second, this dissociation presupposes a conception of attention as some kind of mechanism that acts on information.29-38 According to Raftopoulos, attention is the result of biased competition among pieces of information along the visual circuits. Biases can involve top-down cognitive information, and both prior expectations and attentional commands are such biases. 17-18 The phenomenon of attentional modulation of spontaneous activity occurs when attention is shifted to the location before the stimulus and increases the baseline activation of neuronal ensembles tuned to the attended location in specialized extrastriate areas V2, V3, V3a, V4 and in parietal regions and striate cortex V1. 29-38 The basal activity of neurons increases at all levels of the visual cortex, and the spontaneous firing rates of neurons are increased when attention is shifted to the location, and thus spatial attention increases the sensitivity of neurons tuned to the attended spatial location, improving the signal-to-noise ratio of neurons tuned to the attended location over neurons with receptive fields outside the attended location that contribute only noise. 29-38

Spatial attention determines the focus of gaze, but it does not solve the problem of attentional gaze. What is perceived depends on the relative activity of appropriate sets of neurons that selectively encode stimulus features compared with the activity of sets that do not encode stimulus features and contribute noise. 29–38 In fMRI experiments designed to examine the effects of attention to color and motion features in visual, frontal, and parietal areas, a cue appeared 1 s before the stimulus. Activity within color-sensitive visual areas and motion-sensitive visual areas was increased by attention to color and motion, respectively. This resulted in the relevant visual areas that encode color showing enhanced activation as early as 80 ms after stimulus presentation. 29–38

Cognitively guided spatial attention may determine where one focuses before stimulus presentation and thus before the onset of initial vision, although attention can affect both the pre-early vision and early post-vision stages of visual perception. 29-38 Feature/object-based attention can prime the perceptual system to process some items in the visual scene more quickly and effectively by setting the values of some parameters of the rules governing state transformations during perception. 29-38 Attention affects perceptual processing during late vision, which is an early post-vision perceptual stage. This implies that the transmission of signals during early vision is not affected by top-down signals produced in cognitive areas and is restricted within the visual areas of the brain. 29-38

4.2.2.4 Value-Driven Attentional Capture

Vidnyánszky Z et al. showed that the attentional mechanisms themselves are modified during learning. Attentional suppression of task-irrelevant stimuli becomes more efficient with practice.25-34

Studies have shown that attentional learning is stimulus-specific and persists over several weeks, suggesting that plasticity of attentional mechanisms is an inherent component of visual perceptual learning.25-34

4.2.2.5 Encoding

Successful object encoding involves multiple cortical regions across the hippocampus and features areas that intersect with networks involved in visual object processing and semantic cognition.33-40

The specific memory traces that contribute to true recognition depend on the encoding of perceptual features, while representations of semantic gist promote true and false recognition.33-40

A key aspect of contextual modulation is that information is encoded in a relative manner, with contextual inputs controlling the transformation between boosting input and augmenting output, producing an encoding of input information dependent on the motivating or interesting spatiotemporal environment.33-40

Similar adaptive value encoding occurs in the monkey anterior cingulate cortex and midbrain dopamine nuclei, similar to reward-related processing in the human brain. 33-40 A key step in examining neural value coding is to distinguish issues related to the representation of decision value from other forms of reward-related activity.22-24 Various neural responses may appear closely correlated with value but instead encode other forms of related information. In the midbrain, dopamine neurons reflect reward prediction error, a quantity that encodes the difference between expected and received reward value. 33–40

Although value coding has been examined in several brain regions, including the orbitofrontal cortex, dorsolateral prefrontal cortex, and basal ganglia, we focus here specifically on value representation in the lateral intraparietal area (LIP). 33–40

Indeed, intention-related activity appears to be a general feature of the posterior parietal cortex, with distinct effector-specific subregions representing the planning of different motor actions. 33–40

Options differ in their associated rewards, and choice is driven by evaluation and choices about potential outcomes. In contrast to perceptual tasks, in choice economics, the relevant decision variable depends on subjective evaluation rather than external sensory information. 33–40

Furthermore, LIP neurons simultaneously encode both reward magnitudes and perceptual cues in variable-reinforcement motion discrimination tasks, consistent with a general subjective value measure that integrates outcome and probability information. 33-40 As expected for a decision variable representing subjective value, LIP value coding incorporates the influence of all relevant behavioral costs and benefits. In a temporal discounting task, LIP activity reflects the individual-specific decrease in reward value driven by imposed reward delays. 33-40

Thus, firing rates in LIP represent a consistent value that signals both the objective characteristics of rewards (delay in reinforcement) and the subjective weighting of relevant information about rewards (delay in discounting function). Value representation extends to the brain, areas responsible for different motor effectors. For neurons in the medial intraparietal area of the posterior parietal cortex representing the specific arm, movements are modulated by the associated value. 33-40

4.2.3 Phase 3: Notion Perception

Spatial cognition corresponds to an individual's ability to perceive social relationships between individuals with the ability to comprehend effectively, with depth and solidity. With respect to this stage, a significant task-dependent role is assigned to the frontal cortex in matching incoming sensory information with a mental model. 33-40

4.2.3.1 Late Vision

It is during late vision that hypotheses about the identity of the object(s) in the visual scene are formed and tested against the information contained in the proximal image that is transmitted to late vision (whose output is the input to the late vision processes) selecting from the proximal image only confirmatory information and ignoring or rejecting disconfirmatory information. 33-40 The epistemic role of early vision is determined by the fact that early vision retrieves from the visual scene information that is fed to late vision and is used for the construction of the percept in the formation.

4.2.3.2 Reasoning

Reasoning is a complex cognitive process that involves attention, memory, executive functions, symbolic processing, and fluid intelligence, through which several brain regions are inevitably implicated in the orchestration of the process. 33-40 Among the different categories of reasoning, inductive reasoning involves inferring underlying relationships from multiple instances. 26-42 As for deductive reasoning, this process requires inferring a definitive conclusion from information processed by perception. 33-40 People work with a set of premises and derive a conclusion that is not explicitly stated in the initial premises, and therefore, several mental processes are involved for successful performance in deduction, such as premise encoding, premise integration, and conclusion validation. 26-42

Both inductive and deductive reasoning rely on multiple mental processes that dynamically interact with each other, being intrinsic to high-level human cognition. 26-42 Neurobiology and fMRI studies have shown that inductive reasoning involves activation of several regions, including the left inferior frontal gyrus, precentral and superior frontal gyrus, bilateral middle frontal gyrus, bilateral superior parietal lobule, right precuneus, left inferior parietal lobule, and right superior occipital gyrus. 26-42 In the inductive type of reasoning, researchers have argued that the left frontopolar cortex is necessary for inductive processing. 33-40

The fMRI studies have demonstrated that the "core" region of deductive reasoning is in the left rostrolateral prefrontal cortex and medial superior frontal gyrus, bilateral middle frontal gyrus, and bilateral posterior parietal cortex. 33-40 A common pattern of activations of inductive and deductive reasoning has been co-located with the multiple demand system, indicating that reasoning is a high-level convergence of complex cognitive processes.26-42

4.2.3.3 Choice

Social choices and decisions can be made at three different levels: for oneself, for others, and in accordance with social norms.37-43

The last stage ends with the

response to the action, along with the evaluation of the effect produced, since not checking the effect can be a perceptual error, as in some distractions.37-43

Neurons in the LIP area of the parietal cortex respond to visual stimuli in a region called the response field. 37-43

During the decision process, LIP neurons represent the accumulated evidence that one of the choice targets is a better choice (given the task) than the other. 37–43 While MT neurons are firing at a roughly constant rate, neurons in the LIP gradually increase or decrease their firing rate as more evidence accumulates for or against one of the choices. 37–43

If the stimulus is turned off and a delay period occurs, MT neurons return to their baseline firing rates, but LIP neurons whose response fields contain the chosen target emit a sustained discharge that indicates the outcome of the decision. 37–43

However, the firing pattern of neurons representing momentary evidence is entirely caused by input from other neurons, many of which are already in a continuum of activity and others are 'dormant.'. 37–43

The prefrontal cortex plays an important role not only in determining which events to perceive but also in which of the corresponding response dispositions to select and actualize in overt behavior. 37–43

Thus, action selection is the result of competition between response tendencies in the context of prefrontal bias signals representing goal drives and strivings. 37–43 Action selection can be decoupled from drives and strivings as a result of a lowering of the threshold for action selection. The prefrontal cortex (PFC) plays an important role not only in determining which events to perceive but also in which of the corresponding response dispositions to select and actualize in overt behavior. 37–43 Thus, action selection is the result of competition between response tendencies in the context of prefrontal bias signals representing goal drives and strivings. 25–30 The assessment of momentary behavioral prediction capabilities is critical to compensate for the intrinsic delays that our sensory and motor systems may present in processing incoming information and in generating behavioral responses.

4.2.4 Phase 4: Self-observation and Emotional Intelligence

Effective self-observation is a neurocognitive task that focuses on internal processes, identifying eliciting emotions, and identifying (requiring training) activations of automatic cognitive and behavioral states, such as family schemas. 37-43 Cognitive Control (CC) allows stimulus-response processing to be aligned with internal and external goals, which is essential for conscious (purposeful), intelligent, rational action, expected according to the professional, family, social context and according to its regulations, rights and duties. 37-43

The role of the PFC in the CC essentially consists of contextual bias to resolve conflicts and exercise attentional control. 37-43

According to Müller-Pinzler L, the anterior insula/anterior cingulate cortex network simultaneously processes one's own bodily arousal during these interpersonal emotional experiences. 37–43

The mechanistic explanation of emotion perception consists of constructivist theories, which argue that the emotions of others can be accurately inferred from a combination of perception of motor expression, contextual processing, and conceptual knowledge about the relationships between emotions, desires, and beliefs. 37–43 When the observer learns through experience to associate certain motor expressions with certain emotional experiences through a process of bootstrapping (construction carried out through experience and without external assistance). 37–43

Categorical and continuous perception often occur simultaneously when processing the emotions of others: the former allows a gestalt perception of a single emotion, while the latter allows us to perceive subtle variations within an emotional construct. 37–43

However, categorical perception seems to dominate the way we process and attribute emotions in others, and the reason for this may be to achieve cognitive efficiency by parsing information into meaningful but limited chunks of information. 37–43 In interpersonal relationships, these mentalizing network regions show similar levels of activation for mental and non-mental judgments (as opposed to the pattern of activation seen in the in-character condition), highlighting the importance of studying social processing within a second-person framework.30 An important question for future second-person neuroscience research will be whether mentalizing network activation for non-mental state reasoning about a social partner is driven by spontaneous mentalizing or by a more primary computation critical to social interaction that is not typically elicited in 'observational' studies of social processing, such as coordination of attention or perspectives with a social partner in real time.37–43

Second-person fMRI studies have shown that the mentalizing and mirror networks show increased functional connectivity in viewing communicative moments. During an interactive game of charades, interbrain functional connectivity is seen between the mirror and mentalizing networks such that neural activity within the gesturer's pMNS can predict activity within the guesser's pMNS and in the mirror network region. mentalizing (vmPFC).37-43

Studies investigating the inhibition of spontaneous imitation provide some insight by suggesting that mentalizing (mPFC) regions may act to control automatic shared representations between social partners, reflected in pMNS activation. 37–43 Thesementalizing network interactions extend beyond the mirror neuron network, as second-person studies have shown simultaneous activation and functional connectivity between reward or arousal and mentalizing networks during interpersonal interaction. 37–43

In traditional models of action understanding, these systems therefore support distinct computations, with the pMNS supporting inferences related to the "how" (kinematics) and "what" (goal) of action and the mentalizing system supporting inferences related to the "why" (explicit reflection on intentions). 26 Listening to speech (without mental state content) from a live (non-recorded) social partner, or engaging in gaze-based interaction with another person, involves regions overlapping with those involved in explicit mental state reasoning. 37–43 It involves sudden, instinctive, and contagious emotional reactions. The lack of control over these reactions can lead to emotionally motivated judgments and behaviors. 7-13 In the absence of emotional intelligence, which is evidenced by the absence of the capacity for mentalism, an empathy deficit occurs, and individuals start from general principles about how someone should behave emotionally and then contextualize them to more specific situations and constraints. 7-13

The perception of emotions relies more on dynamic cues for successful recognition, and fMRI studies have shown that the superior temporal sulcus (STS) plays an important role in this process. 37 This region is more generally sensitive to dynamic facial cues and biological motion (walking and other naturalistic movements) and may serve to integrate multimodal information into social perception. 37–43

Neuroimaging evidence shows that the amygdala responds to facial trustworthiness, with some amygdala subregions showing linearly increasing activation for less trustworthy-looking faces, consistent with a role for the amygdala in threat surveillance. 37–43

Other subregions show increasing activation for more trustworthy or untrustworthy faces relative to neutral ones, consistent with amygdala roles in processing affective significance in general (regardless of valence) and in responding to motivationally relevant stimuli. 37–43

Both types of amygdala responses are observed even when faces are presented subliminally, demonstrating the amygdala's ability to extract even high-level social information from faces rapidly and automatically, even in the absence of conscious awareness. 37–43

In terms of visual processing of facial features associated with trustworthiness categorizations (rather than rapid processing of their salience/affective significance), the fusiform gyrus (FG) likely plays an important role. 37–43

Although the vast majority of work in social and cognitive neuroscience has focused on the determinant cues and bottom-up mechanisms that underlie social information extraction, recent work suggests that this process is sometimes significantly influenced by higher-order social cognitive factors of the perceiver, including prior knowledge (stereotypes or conceptual knowledge), attitudes, and motives. 37–43

These conceptual associations then effectively become implicit predictions that shape the course of perception, biasing it to align with those predictions. 37–43

Biographical and behavioral information about a person (particularly with affective or moral content) can influence attention and perception and shape representations in the FG. 37–43

The recurring conclusion in this line of work is that higher-order social cognitive processes can be seamlessly integrated into perceptual processing, fundamentally shaping social perception. 37–43

The object recognition literature demonstrates a role for the orbitofrontal cortex (OFC) in visual perception, such that it is recruited when incoming visual input matches a pre-existing representation in memory or a task-based prediction, allowing it to potentially take on some of the visual processing load. 37–43

In particular, the medial OFC (mOFC) appears to be responsible for making connections between visual input and associations in memory. Coarse, low-spatial-frequency input is sufficient to drive this expectation- and prediction-based activity in the OFC, suggesting that the OFC exerts these visual predictions on category association before categorization is complete. 37–43

Overall, this work suggests that the OFC provides automatic visual predictions, including those based on social concepts and stereotypes, to ventrotemporal regions involved in face perception. 37–43

While this is often seen as adaptive in the context of object recognition (facilitating recognition of an object in a congruent context that makes the object's presence more likely), in the context of social perception, the context may include stereotypical associations, and top-down signals in perception may in many cases be considered dysfunctional and maladaptive.37–43

If the OFC is capable of using stereotype-based expectations or other conceptual associations to form implicit visual predictions that modulate ventral-visual representation, it is likely that the anterior temporal lobe (ATL) could be an important source of these associations. The ATL is consistently implicated in the storage and retrieval of semantic information.44-46

4.2.4.2 Agency and Responsibility

The perception of our behaviors is composed of a desire to act (volition) and a sense of responsibility for our actions (agency). Current neuroscience studies on self-perception have focused on the division into two processes: the intention or motivation to act, referred to as volition, and the sense of responsibility for one's own action, referred to as agency. 48–49

Lesions that disrupt agency also occur in many different locations but fall within a separate network defined by connectivity with the precuneus. 48–49

Brain lesions that disrupt volition occur in many different locations but fall within a single brain network defined by connectivity with the anterior cingulate. 48–49 This view has received considerable empirical support from studies showing that spatial and temporal discrepancies between performing an action and viewing visual feedback of the action reduce the sense that the observed action is the same. 48–49 Thus, introducing a spatial transformation between an action and its visual consequences reduces participants' sense of agency in proportion to the induced mismatch. The so-called "intentional binding" effect provides another line of evidence for the role of temporal contiguity between action and outcome in constructing agency. 48–49

Haggard et al. used the term intentional binding effect to represent the subjective compression of the temporal interval between a voluntary action and its external sensory consequences.48-49

The intentional binding effect would constitute an implicit but reliable measure of agency, since it only occurs when events in the external environment are accurately recognized as consequences of one's action.48-49

Thus, a reliable and explicit sense of agency can only be formed when visual, motor, or prop However, one cannot feel agency over any event until that event has been registered and processed in the brain. As a consequence, agency can only be attributed retrospectively, although it is informed by online signals about motor orientation and control. 48–49

However, the sense of agency is also generated prospectively, prior to the action itself and before knowing the actual effect of the actions. 48–49

Similarly, errors in task performance can lead to a feeling of disfluency during the task, without any explicit awareness of an error and without the ability to explicitly report the error. 48–49

The term "epistemic feeling" has been coined to describe this subjective, online experience of an error. 48–49

The sense of agency relies heavily on action selection processes that necessarily occur prior to the action itself. 48–49

A strong sense of agency may be associated with fluent and uncontested action selection. In contrast, conflict between alternative possible actions, such as that caused by incompatible subliminal priming, may reduce the feeling of control over action outcomes. 48–49

Prospective agency may therefore reflect learned experiential metacognition: if we can fluently select an appropriate action, then we are likely to get what we want or carry out our true intentions. 48–49

The ability to monitor fluency signals generated during the selection of actions in agency is an important sign of what makes our action intentional and is therefore an essential component of the experience of agency, defined as the feeling that we are intentionally making things happen through our own choices and actions. 48–49 The sense of agency is characterized as the experience of generating effects in the external world through one's actions. It is a pervasive and deeply adaptive event of cognition that emerges into conscious experience through mechanisms involving the planning and execution of intentional action, without penetrability.

Disrupting LPFC activity impairs the integration of moral blameworthiness assessments into punishment decisions. 48-49 The LPFC is implicated in orchestrating the influence of moral norms on behavior, and its activation is increased as people choose to comply with norms of justice, reciprocate trust, and avoid harming others for personal gain. 48-49

The brain reacts with initial resistance to any situation of change through amygdala activity. However, such resistance can be exaggerated and intense due to neuronal hyperconnectivity, and this can generate impairments such as personality rigidity. 48-49

By inference from this model of perceptual errors, prejudices have a neurological function of avoidance, escape, aversion, and punishment, as they reflect fear about something or someone. 48-49

In the issue of mental health and mental disorders, prejudice, stigma and discrimination are clear examples of errors of perception, characterized by the decrease in its value, which alters the real notion, generating a sense with little diligence, beliefs of complexities, stigma, discrimination, prejudice, psychophobia and mainly neglect.48-49

4.2.5 Phase 5: Perception of Execution

4.2.5.1 Social decision making

Real-world social interactions require an individual to use previously acquired information about a social partner to iteratively predict their subsequent actions.20-30 Second-person social decision-making studies examine this process by contrasting conditions in which a participant plays strategic games with a human social partner with those in which they play against a computer using dual- and single-brain methods, and observed that strategizing against a human generates greater engagement of mentalizing network regions, mainly the medial prefrontal cortex (mPFC) than playing against a computer.20–30

Subsequent studies have identified a unique role for the TPJ in predicting an opponent's actions and have demonstrated that TPJ activation and synchrony of activity within the TPJ between social partners can be modulated by the perceived "sociality" of the agent (whether the interaction is face-to-face or whether the interaction occurs with a computer versus a contingent robot versus a human social partner).20–30 Studies of second-person social decision-making have also shed light on the neural correlates of two key social-interactive processes: trust and reciprocity.20–30

Regions of the brain's reward and salience networks have been identified as important in developing a model of an opponent's actions that affects trust and reciprocity decisions, with the Nac influencing trust decisions, and the anterior insula and caudate involved in reciprocity decisions and feedback learning. 20–30 These studies have relied primarily on iterative trust games in which an investor decides how much money to share with a trustee (a measure of intention to trust) and then the trustee decides how much to return (a measure of reciprocity). 20–30

In pioneering work using a hyperscanning (simultaneous dual-brain) approach, one study compared neural signals from the trustee's caudate and the investor's cingulate during trust decisions. 20–30 Over the course of the trust game, activity within the trustee's caudate changed: the peak response initially occurred after each repayment amount was revealed, but as the game progressed, the peak response began to occur before the repayment amount was revealed, reflecting a shift from this region's involvement in responding to the investor's actions to its involvement in predicting the investor's actions. 20–30 The proposal for a common mechanism for decision making and working memory is supported by physiological observations that single-neuron activity signals correlated with both processes are found in the same brain regions, such as the prefrontal and parietal cortices, and by a recent human study showing that disruption of the prefrontal cortex (known to be important for working memory) causally affected decision making. 20–30

Deficits in working memory (maintaining and manipulating information) are associated with dysfunctional behaviors. This relationship suggests that difficulties in retaining knowledge of consequences (maintaining information) and applying that knowledge to new practical situations (manipulating information) may inform poorer decision making. 20–30

It was soon recognized that this slow-reverberation mechanism is precisely what is needed for decision-making computations, because a decision

4.3 Working Memory

According to Anderson BA et al., visual working memory capacity is correlated with the magnitude of attentional capture by salient and task-irrelevant stimuli, an effect believed to reflect individual differences in a general ability to resist distraction and, therefore, maintain items in working memory.34-37

Furthermore, they conclude that vulnerability to this value-driven attentional capture covaries between individuals with working memory capacity and trait impulsivity.47

5. Positively Modulated Cognitive Penetrability (PCMP)

5.1 Familiarity

The initial effects of familiarity can be explained by the invocation of contextual associations (target-context spatial relations) that are stored in early sensory areas to form unconscious perceptual memories that, when activated from input signals carrying the same or similar target-context spatial relations, modify the feed-forward scanning of neural activity, resulting in facilitatory effects. 35-49

What is involved in the phenomenon are certain associations built into the early visual system that, once activated, accelerate feed-forward scanning. This is clearly not **a case of top-**

down cognitive effects on early visual processing. 35-49

5.2 Positive Parenting or Parental Competence

Positive coparenting includes family cooperation and integrity, support/mutuality characterized by the mutual involvement of parents and child, that is, interpersonal relationships between parents and children rich in synchrony. 35-49 Affiliative behaviors are those that include social bonds between individuals, including bonds between partners and parents with their offspring. 35-49 From an evolutionary perspective, social bonds serve to reduce stress and anxiety, increasing security, and thus the formation of social bonds helps to maintain groups or pairs of individuals together in harmony.35-49

Cross-sectional studies have confirmed that positive coparenting is associated with fewer internalizing/externalizing behavior problems, in addition to being a positive predictor of children's prosocial behaviors after 6 months. The family voice presents substantial functioning through neuronal activation in the child and can present beneficial situations such as stress regulation, increased confidence, and being understood and accepted. 35-49

In one study, participants reported 10–20% greater comprehension of sentences when spoken by their friend or spouse than when spoken by a stranger.35-49

5.3 Mutual Engagement

A central feature of all social interaction is that both partners are mutually engaged, meaning that each person in the dyad knows that his or her actions are directed and relevant to his or her partner, and vice versa, and thus produce effective effects.46 This sense of mutual engagement is challenging to obtain in traditional cognitive neuroscience experiments that lack reciprocal social interactions or use stimuli that make it clear that no actual interaction partner is co-present.47

However, second-person approaches have been developed to examine mutual engagement using both bottom-up and top-down engagement cues. 35–49

A bottom-up approach to achieving a sense of engagement is to present stimuli (such as videos or photos) that stimulate a sense of individual approach.44 These communicative gestures can be contrasted with third-person stimuli that have no inherent communicative value (such as scratching one's face) or are directed at another person. 35–49

A limitation of studies that have used communicative gestures to generate a sense of engagement is that there is no reciprocal interaction. The participant feels engaged, but this engagement is unidirectional because the participant cannot influence or synchronize with the agent. 35-49

Rerceiving contingency in response to one's own actions is a strong indication of mutual engagement and social agency.47-50

One study demonstrated that when participants perceive that an avatar is responding to their actions in a human-like manner (with eye movements that are contingent on the participant's gaze, but not perfectly contingent), the ventral striatum and orbitofrontal cortex (the reward system) are engaged to a greater extent than when participants perceive that a computer is controlling the avatar.35-49 For an individual engaged in a dyadic social interaction, reciprocal relations (that is, the mutual effect of each participant on the other as a result of actions they decide to take during the interaction) are not the only way to learn about the interaction partner. 35–49

In studies of mutual engagement, reciprocal interaction, and communication, findings from second-person neuroscience have challenged the traditional view of how the brain infers and reasons about the mental states of others, including their goals, intentions, and beliefs. 43–49

These mental state reasoning conditions are contrasted with nonmental reasoning, such as reflecting on social (but not mental) aspects of a person. 35–49 A seemingly distinct system, the putative mirror neuron system has been shown to be engaged when participants make inferences about a person's intentions or goals based on their actions, and because these regions are also engaged during the execution of the same action or goal, this system is sometimes thought to support a simulation process that allows for understanding the action goals of others. 35-49

5.4 Oxytocin

The neuropeptide oxytocin (OT) plays a central role in regulating affiliative bonds and anxiety, and physiological synchrony is measured in research through Social memory, as part of social behavior, is based on the ability to recognize conspecific forms (relatives, companions, descendants, allies, and enemies), and deletions in the CD 38 gene are correlated with deficits in this memory. 11-12

Oxytocin is important for the processing or retention of direct and indirect social information. The specific pattern of oxytocin secretion is related to the characteristics of behavioral reactions. 11-12

Studies have shown that oxytocin decreases the firing frequency of neurons in the central amygdala that project to the hypothalamic and brainstem regions, which trigger fear responses. 11-12

Oxytocin decreases the firing rate of central amygdala neurons and synergizes with dopamine in the ventral striatum to promote social bonding.11-12

Patin A et al., showed that oxytocin attenuates the response of the ventral tegmental area to reciprocal cooperation and reduces the salience of positive social interactions in women, in addition to preventing habituation to negative social interactions among men.11-12

Studies have shown that intranasal oxytocin attenuated amygdala responses to emotional faces, regardless of valence, improved "mind reading", attenuated empathy-related activation within the neural circuit of pain, and also increases paternal sensitivity and decreases hostility in interactions with both typically developing children. 11-12 Oxytocin positively modulates perception of another person's emotional state, improving an individual's ability to produce normative ratings of others' emotions based on images of the eye regions of healthy adults. 11-12 Brain oxytocin levels are increased in individuals with higher constructive approaches compared to those with avoidant attachment, thus it may play an important role in promoting health and in interpersonal interactions in families and couples. 11-12

6. Negatively Modulated Cognitive Penetrability (NMP)

Studies have shown that early sensory areas exhibit plasticity related to valence processing, which is considered a "core" affective feature of our emotional lives. 17-18 Late negativity appears to be related to higher-level conflict monitoring associated with response choice discrimination, but not when the presence of cognitive conflict is associated with response inhibition. 17-18

Normalization shows that this negativity remained present in the ERP up to 200 ms after stimulus presentation, which means that this negativity can be interpreted as an effect on visual processing at the time of attentional modulation of the ERP. In view of the fact that attentional modulation of the occipital visual areas is delayed in time and occurs after 170 ms post-stimulus. 17-18

6.1 Impulsivity

Impulsive choice, often characterized by an excessive preference for small short-term rewards over larger long-term rewards, is a prominent feature of several Mental Disorders (MD). 23-36

The neural mechanisms underlying impulsive choice are not well understood, but increasing evidence implicates nucleus accumbens (NAc) dopamine and its actionsto "low arousal tone" in the visual cortex. 23–36

7. Perceptual Errors

Valuable stimuli strongly modulate voluntary attention allocation, but there is little evidence that high-value but contextually irrelevant stimuli capture attention as a consequence of reward learning. 23–36

Anderson BA et al. demonstrate that visual search for a salient target is slowed by the presence of a discrete, task-irrelevant item that has been previously associated with monetary reward during a brief training session. Thus, arbitrary, neutral stimuli imbued with value through associative learning capture attention powerfully and persistently during extinction, independent of goals and salience. 47

However, human consciousness can suffer from errors of perception due to dysfunctions in the processing of stimuli and information through various neurobiological mechanisms, such as maladaptive, genetic, and epigenetic processes, learning from various factors such as experience, specialized knowledge, addictive habits, culture, neurological injuries, senility, and exogenous intoxication. 23-36

In addition to the PCMN processes, as a clinical characteristic, changes in interpersonal synchrony deficit, processing reaction time disorders, decreased processing speed, absence of processing (parietal hemineglect), and shortening/anticipation of perception phases (impulsivity), intrinsic processing errors (Stroop effect). 23-36

Distortions of thought, self-image, stigmas, prejudices, affective neglect, ableism, insecurity, generalization and neurodysfunctional judgments, family conflicts, parental alienation, addictions, and behavioral deviations are also characteristic. A central default navigation network (DMN) of amygdala dominance, with activity from the hippocampus, insular cortex, dorsolateral PFC areas including the anterior cingulate, dorsal, basal forebrain (BF), ventral tegmental area (VTA), and lateral hypothalamus (LH) are among the structures involved in the regulation of reward. 23–36

Research also suggests that an individual's prejudice and evaluative biases toward specific social groups can impact visual perception of them. However, multivariate approaches show that race can still be classified by different neural patterns for own-race versus other-race faces (within the same minimal group) in the FG, and that categorical group and race distinctions in the FG are sensitive to current processing goals (task-based attentional shifts). 23–36

Empirical evidence has shown that object/feature-based attention and cognitively driven or endogenous spatial attention can lag and affect visual brain areas (from V1 to IT) after 150 ms post-stimulus, meaning that their effects are felt in visual brain areas after the initial viewing period, and thus attention can negatively modulate perceptual processing. 23–36

The effect begins 70–90 ms after stimulus onset, meaning that it is clearly an early perceptual rather than a post-perceptual effect. Spatial selective attention increases the activation of neural sites tuned to the selected loci. 23–36 The effect is sensitive to stimulus factors such as contrast and position. It occurs before stimulus identification and is insensitive to stimulus identity. It is independent of the task relevance of the stimulus, since it is observed for both targets and non-targets. It is also independent of the nature of the task, since it is observed for a variety of tasks ranging from passive viewing to active search locations. 23-36 Value functions serve to integrate all decision information into a single metric since they involve representations of meaning, degree of importance, and measures of intensity for comparison and choice. 23-36 In reinforcement learning models, agents learn a value function of this type based on the rewards experienced after a given action. 23-36

The development of a normative framework based on values is fundamental to understanding how people assign values in risky decisions, of which the outcomes are probabilistic and extracted from known data. 23-36

7.1 Perceptual Errors with Emotional Value Bias

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In reinforcement learning models, agents learn a value function of this type based on the rewards experienced after a given action. 1

Developing a normative framework based on values is fundamental to understanding how people assign values to risky decisions, the outcomes of which are probabilistic and drawn from known data. One such structure is the amygdala, which works concurrently with sensory and higher-order cortices to tag incoming sensory information with contextual relevance and thus d etect this relevance in the next encounter with that stimulus or circumstance. 26–42 The fear conditioning procedure instills an initially neutral stimulus with the capacity to induce biologically relevant responses and behaviors (freezing or fleeing) upon consistent association with an unconditioned aversive stimulus. 26–42 The wide variety of cortical and subcortical projections to and from the amygdala provide it with information about the properties of the stimulus as well as the organism's ongoing goals and needs. 26–42.

The overwhelming evidence suggests that the right pSTS is involved in decoding and understanding meaningful social actions conveyed by gaze direction, body movement, and other types of meaningful goal-directed movement or implied by spoken words. 26–42

The amygdala is one of the interfaces between sensory cortices and higher-order brain structures and the major culprit of cognitive impairment due to its sudden aberrant inputs and its habituation of mild or intense activity in maintaining awareness considered normal by the individual. Another frontal brain structure consistently recruited during perceptual decisions about emotions is the dorsomedial frontal cortex (dmFC). 26–42

This structure is predominantly involved in social cognition, such as forming impressions about others and inferring beliefs, desires, and intentions. 26-42 Five distinct striatal zones have been linked to distinct brain functions: the anterior caudate for incentive behaviors and the evaluation of different actions, the posterior caudate for executive functions, the posterior putamen for sensorimotor processes, the anterior putamen for social functions, and the ventral striatum for the representation of stimulus value and motivational states. 12-34 Studies have found that the putamen exhibited a higher anticipatory response to reward in males than in females. 12-34 They also responded faster and gained greater rewards in risky decision-making and showed increased activation in the dorsal striatum, including the putamen. 12-34

Regarding the functional aspect of the dorsal and ventral striae, the direct striatonigral pathway and the indirect striatopallidal pathway in the dorsal striatum preferentially control movement, whereas their counterparts in the ventral striatum preferentially regulate aversive responses and reward-seeking emotion. 12-34 The NAc plays a key role in aversive learning and learning flexibility. Activation of D1 receptors in the direct pathway significantly controls reward behaviors. 12-34

Inactivation of D2 receptors in the indirect pathway controls avoidance behaviors. Aversive learning is regulated by a set of receptors involved in the induction of long-term potentiation of cortico-accumbens synapses.12-34 The term "unity and diversity" (UD) is used by neuroscientists to describe the relationships between these diverse frontal lobe processes, responsible for an "irrational variety" in human reactions, even to restricted and non-progressive lesions of the prefrontal regions, characterized as "compulsivity" or "abnormally stimulus-attached behavior."12-34

The common and basic element of UD is "neglect of goal or disregard of a known task requirement." In threat situations, amygdala hyperreactivity exerts a causal and/or chronic contributing factor.12-34

However, the current literature in healthy samples shows greater test-retest reliability for amygdala habituation, the change over time in response to repeated stimuli, than for its reactivity to threat. 12-34 The ventromedial prefrontal cortex is involved in social reasoning and decision-making, the amygdala in social judgment of faces, the right somatosensory cortex in social reasoning and decision-making, and the right somatosensory cortex in social judgment of faces.

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The ventromedial prefrontal cortex is involved in social reasoning and decision-making, the amygdala in social judgment of faces, the right somatosensory cortex in empathy and simulation, and the insula in autonomic response. 12-34

A corresponding deficit in frontal cortical functioning plays a central role in mediating fear extinction, and associated deficits in appreciation of the safety context are related to hippocampal function. 12-34

Indeed, there is evidence for cross-modal affective prediction: when auditory emotional prosody is incongruent with a preceding emotional facial expression, there is an increase in neural activity in the auditory cortex, which can be interpreted as prediction error. 12-34

Because predictions are not stationary and because prediction errors are naturally contingent on predictions, the neural activity underlying affective experience will depend on which aspects of an evocative stimulus are meaningful and present ongoing predictions of threat or violation.12-34

The fear conditioning procedure instills an initially neutral stimulus with the capacity to induce biologically relevant reactions and behaviors (freezing or fleeing) upon consistent association with an unconditioned aversive stimulus.12-34

7.1.1 Negative Parenting

According to Sitoiu et al., the Barnum effect refers to the consultation of non-scientifically validated sources and reliable information that respond to the parents' desires but not to the children's educational needs.37-43

The Barnum effect, also frequently encountered in the field of parenting, involves the recognition of oneself in ambiguous general statements as being descriptive of one's own personality, especially when these statements offer valid perspectives. 37-43 This effect can also be found under the name of the Forer effect, as a result of which it was first demonstrated that individuals willingly endorse universally valid statements as meaningful to the situation in which they find themselves, and individuals tend to accept false statements about themselves, as long as they consider them flattering and positive.37-43

In agreement with the field of parenting, the Barnum effect is experienced in situations in which parents are informed about the upbringing and education of the child by sources that are not scientifically validated, supported by people with no experience in the area or with minimal training in this regard.37-43

As a result of the Barnum effect, parents' perception of parenting is distorted. They believe that the parenting practices identified in different sources are applied regardless of the specificities of the child, not giving due attention to the child's needs.37-43

The experience of the Barnum effect by parents can have negative consequences for child development due to the limitations existing in parenting practices that are not based on scientific information. Even in the presence of a high level of parental education, the Barnum effect is experienced regardless of educational level. 37-43

7.1.2 Schematic Awareness/Family Schemas

Throughout life, the body schema develops based on sensory information used by the body in movement and by its interactions with the environment and people. 37-43 Internal representations, including the body schema and representations of the external world, develop through learning that can be conditioned and are constantly updated based on different sensory inputs. 37-43

Due to the slow maturation of proprioceptive and visual information, which are at the heart of the construction of body schemas, notable differences exist between adolescents and young adults, both at the postural and perceptual levels, which confirms the late maturation of multisensory integration for central and anticipatory motor control. Family schemas (FSs) develop due to maladaptive reasons, and are therefore dysfunctional, and eighteen types of FSs are currently described. An individual may present activation of more than one schema at the same time, and may be activated twenty-four hours a day. 37-43

The EFs are automatic, sudden, and function as non-self-identified or non-perceptible (unconscious) mechanisms that affect behaviors, cognitive states (perception, distorted and biased beliefs), and physiological states such as hormonal dysfunctions and neurodysfunctions of emotions, which begin in children and persist into adulthood. 37-43

The EFs occurring unconsciously between peers in the family environment (bidirectional), through activation of the amygdala neurological systems and also through a process of neuromirroring (unconscious neuroactivation) of "mirror neurons." 37-43 Typical EFs include avoidance, denial, aversion, escape, punishment, ableism, prejudice, devaluation, and distortion of beliefs, which result in toxic relationships, chronic family fights, and cases of dysfunctional parenting. 37-43

1) Disconnection/Rejection: inability to form secure bonds, with experiences of negative social experiences. In general, people tend to present characteristics of instability, abuse, coldness, rejection or isolation from the outside world. Five schemes are linked to this domain: Abandonment, Distrust, Emotional Deprivation, Defectiveness/Shame and Social Isolation.

2) Impaired Autonomy and Performance: Presents dysfunctional expectations about themselves and the world, which interfere with their ability to differentiate themselves from paternal or maternal figures and function independently. The family of origin is overprotective and cannot stimulate them to perform competently. The schemes in this domain are: Dependence/Incompetence, Vulnerability to harm or illness, Enmeshment and Failure.

3) Impaired Limits: There is no development of internal limits and responsibility towards others. People can be selfish and spoiled, and most of the time, they grew up in permissive families. The schemas associated with this domain are: Grandiosity/Arrogance and Insufficient Self-Control/Self-Discipline.

4) Other-Orientation: excessive emphasis is placed on meeting the needs of others rather than one's own. The emotional needs and desires of the parents are valued more than the needs and feelings of the child. The EFs developed are: Subjugation, Self-Sacrifice, Approval-Seeking/Recognition-Seeking.

5) Overvigilance and Inhibition: excessive emphasis on suppressing feelings, impulses and spontaneous personal choices, reinforcing compliance with rigid internalized rules regarding one's own performance (perfectionism and self-demand). The family is severe, demanding and punitive. The EFs

associated with this domain are: Negativism/Pessimism, Emotional Inhibition, Inflexible Standards and Posture.

According to Mason, Platts and Tyson, EFs have a self-propelling nature and resistance to change. They end up constituting the core of the individual's self-concept and worldview, in which change is seen as threatening. 37-43 However, maternal or paternal speech commands can generate schematic activation and carry out belief adaptation, in addition to generating disconnection between cerebral hemispheres. 37-43

7.2 Perceptual Errors by Monetary Acquisition Value

The brain processes three sources of motivation: extrinsic rewards, moral values, and image concerns. 37-43

According to decision neuroscience, when choosing whether to accept or reject an offer that weighs two types of attributes (moral values and money), the brain assigns a value to each option and compares them, calculating their difference. 37-43

Current models of predictive processing suggest that there may be many different brain states that give rise to feelings of (dis)pleasure or arousal. Although default mode areas often show reduced overall activity during certain cognitive and attentional performance tasks, they show increased activity during social cognitive tasks. 37-43

This scheme has been applied successively in the field of value-based decision-making regarding various types of benefits (money) and costs (waiting for a long delay). 37-43

Relevant cognitive processes include motivation, reward coding, action evaluation, and executive functions in the context of social interactions. The prefrontal cortex and striatum reflect individual differences in reward dependence. Several studies on the neurobiology of addiction have shown that, at the time of monetary acquisition, there is an intense spike in dopamine release, which can generate an experience of well-being. 37-43

Several studies have shown that the amygdala and orbitofrontal cortex are responsible for processing economic, social, emotional, and motivational rewards. What we pay attention to is influenced by reward learning. Humans automatically attend to stimuli previously associated with reward and to stimuli that have been experienced and conditioned during visual search, even when it is disadvantageous in current situations. Several studies have shown that associative reward learning alters the brain's mechanisms of processing visual stimuli, in the face of learned reward cues that are difficult to ignore. 37-43

This value modulation is influenced by the strength of the behavioral VDAC effect and persists in subsequent processing of the target. Recent studies have demonstrated that VDAC is based on Pavlovian conditioning, and behavioral evidence distinguishes VDAC from other established control mechanisms, suggesting a distinct underlying neurobiological process. 1

The cognitive control system has modulatory effects on reward processing through signaling extrinsic incentives (long-term benefits, reputation building, social norm and sanction, fear of punishment, monetary acquisition), and the social cognition system has modulatory effects on reward processing through signaling trust or threat. 40

Studies using magnetic encephalography have investigated modulations by reward learning, and have shown that VDAC is supported by learned value signals that modulate spatial selection throughout the visual and posterior parietal cortex, which can still occur in the absence of changes in visual processing in the cortex. 1

Several neuroscientists have demonstrated that value signals automatically guide attention to new association situations, which may or may not be beneficial, depending on their congruence with current goals. 37-43

However, we draw attention to the fixation of VDAC on monetary acquisition, through habituation and engrams, which simultaneously activates the reward system, with dopaminergic release, and, subjectively, generates greater survival security.47 This set of mechanisms, in addition to representing errors of perception, justifies various behaviors of exclusive interests in monetary gain, and can hypothesize the pathogenesis of addiction to monetary acquisition. 37-43

8. Superior Attention

In spatial cognition, the ability to ignore a distraction or something that is not valuable at the moment requires active attention, selectively or voluntarily, which presents a top-down attention mechanism.38-45

Ignoring irrelevant information predicts good Superior Attention performance, which involves a high working memory capacity, constant, toned attention, depth and free from habituation or VDAC vices.1

An assessment with Superior Attention with less content of values and previous concepts, performs the encoding of objects with their real value, which can interfere with the real weight that the objects mean, and thus increases the capacity for abstraction and understanding and evidently increases the power of synthesis, organization and resolution, in addition to a fairer or closer to reality assessment.38-45

Green and Bavelier found superior performance in measures of attention capacity, spatial distribution of attention and the ability to process several items over time. 38–45

Attention to scale is necessary for typical conscious visual experience and for goal-directed actions that rely on functional and semantic information. Vertical pathways between the parietal and occipitotemporal cortex, associated with indirect pathways involving the premotor and prefrontal cortex, facilitate attentional operations to scale. 38–45

The indirect pathways, which include the inferior fronto-occipital and horizontal components of the superior longitudinal fasciculi, involve the frontal lobe, working memory, and the “multiple demands” network, which may shape the content of visual consciousness through the maintenance of goal- and task-based abstractions and their influence on attention to scale. 38–45

Sequential effects of reduced behavioral interference following incongruent trials provide a unique opportunity to examine the influence of prior experience on current attentional processing. Behavioral data showed that the task produced a robust interference effect as indexed by a longer reaction time for the incongruent condition. 38-45

Scalp event-related potential analysis revealed greater negative differences in N300 and N570 in the incongruent condition compared to the congruent condition, with N300 being a critical signal for conflict monitoring in the initial stage, while N570 incorporates response conflict in the terminal stage 38-45

8.1 Intelligence

The functional and executive mechanisms of Intelligence refer to the domains of working memory, attentional abilities, and the absence of dysfunctional mechanisms in the perceptual stages that aid in processing speed. 38-45

8.1.1 Restriction of Intelligence

The limitation of recognition to single objects in simultanagnosia may suggest reduced ability in object identification, but other alternative concepts suggest preserved object identification, in which patients can recognize single objects, coupled with impaired spatial attention, which restricts the number of objects that can be perceived.41-47

In addition to inattention to whole objects, there is evidence that patients with simultanagnosia perceive individual objects in a fragmented manner, indicating another manifestation of damage to an object-based attention system.41-47

According to Karnath et al. (2000), "local capture" demonstrates this mechanism, as patients identify the local components of an object but fail to see the global aspect of the object, even with unlimited presentation.48-49 Poort et al. demonstrated that distinct response suppression mechanisms are carried out by inhibitory and excitatory neurons in the visual cortex, associated with top-down input models, and thus generate improved sensory processing due to learning and attention.38-45

The social brain in a neuromaladaptive state promotes dysfunctional inattention, with the aim of avoiding threats of emotional suffering and indirectly generates neglect effects and low diligence processes, which will limit the activity of intelligence, as in the cases of dense intelligence.38-45

If gifted individuals with high EI are characterized by a preference for emotional information without negative cognitive penetrability, they should be more "captured" by emotional stimuli compared to neutral ones.38-45

8.1.2 Value-driven intelligence.

Through the 5-phase multimodal perception model, the set of intelligence (working memory, deep attention, response inhibition) may appear to direct intelligence according to the VDAC, which justifies high intelligence in emotional values in individuals who perform behaviors motivated by emotion.38-45

Individuals with high work skills may have a shift in the entire set involved in the execution of intelligence towards objectives of monetary gain, business, and the value initially captured may be directed only towards monetary acquisition or satisfaction from the work effect, or both. 38-45

However, it is possible that there are simultaneous activities of the emotional VDAC and monetary acquisition, which can generate errors of perception, limitation of intelligence and produce irrational behaviors.1

Successful inhibition of responses to irrelevant stimuli (response inhibition) may depend on sustained attention to relevant information (attention) and working memory.47

According to fMRI studies, states of cognitive and behavioral automatisms, such as amygdala activity, whether due to the function of maintaining rationality or emotional defense inputs, simultaneously and mechanically, is a state of alexithymia that, in emotional cases, has high intensity.38-45

However, it may also be that processing stimuli in two locations requires some expansion of the narrowed attention window, which has a consequent reduction in the spatial resolution of attention as in simultanagnostic individuals, allowing binding errors to occur.38-45

One possibility is that, with cortical fatigue, the attention window closes completely. Another explanation is that information processing within the attentional window may be fatigued. 38-45

Thus, visual stimuli outside the limits of the narrow spatial window of attention are subject to partial or complete representation failures, thus decreasing the executive capacity of intelligence. Working memory is the central intrinsic regulator that orchestrates the phases of perception, as well as simultaneously stimulating adaptive processes such as the reward system and other types of memories. Working memory can also be guided according to the central value obtained in attentional capture. 47

9. Conclusion

The present study demonstrated a multimodal model that integrates several mechanisms that interfere with perception, associated with the robust clinical empiricism that unfolds in clinical neuroscience.

The model captured nuanced patterns of functioning in subfunctions of perceptual neurocognition, which generate cognitive and behavioral patterns of significant neurobiological effect, and which currently contribute to several types of social conflicts, domestic violence, parental neglect, behavioral deviations and addictive disorders.

Anderson BA et al. suggest that this unique form of attentional capture may provide a useful model for investigating cognitive control failures in clinical syndromes in which the value attributed to stimuli conflicts with behavioral goals such as addiction, obesity, as this current model provides.

In the real world, it is not only people with substantial deficits in neurocognition who engage in risky and impulsive behaviors. Estimating the neuromaladaptive variation in neurocognition is crucial to provide a better understanding of its influence on a continuum of neurodysfunctional and malhabitual behaviors.

10. Declaration of conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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