Mental imagery shapes emotions in people’s decisions related to risk taking

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This research project investigates the specific effects of mental imagery on people’s emotional responses and risk-taking decisions. We present findings across four studies, including three experiments, that highlight emotions as a mediator between the valence of mental images related to risk and subsequent risk-taking propensity. Our research identifies two key factors that moderate this relationship: the category of cognitive process (analytical thinking vs. visual mental imagery) and the vividness of mental imagery. In Study 1, we found a link between the valence of mental images and the intensity of emotional reactions, which in turn had an effect on risk-taking willingness. Positive imagery corresponded with stronger positive emotions and increased declared risk taking. The experimental Study 2 provided causal evidence for these associations, showing that participants positively imagining risk-related behaviors reported more intense positive feelings and a greater inclination to take risks than those imagining risk taking in a negative manner. Subsequent preregistered experiments (Studies 3 and 4) corroborated our central hypothesis that mental imagery is a distinct driver of emotional responses in risk-related decision making and showed potential boundary conditions for this effect. Study 3 emphasized that decisions influenced by mental imagery had greater emotional strength than those based on analytical reasoning. The final Study 4 demonstrated that vividness of mental imagery further moderates this effect: more vivid images led to stronger emotions, thus affecting risk-taking propensity. These results underscore the significance of emotions in decision making, particularly when decisions are based on mental imagery rather than analysis, and point to the amplifying effect of image vividness on emotional and decision-making processes.

Minimizing the Influence of Cognitive Ability Facets in Map-Based Route Learning via Instructional Interventions

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Navigational map reading is a daily task, with route learning playing a pivotal role. In this project, we investigated the role of working memory (WM) and perspective-taking ability (PTA) in map-based route learning, exploring whether instructions about efficient map reading can diminish the influence of WM and PTA. Participants (N = 106) memorized a predefined route on a map and subsequently navigated it within a virtual environment. This task was performed twice, with half of the participants receiving specific map reading instructions between the pretest and posttest (instruction condition) whereas the other half not receiving instructions (control condition). The instructions emphasized reading the legend and recognizing landmarks, using landmarks as memorable cues to remember actions, considering the navigation perspective during map reading, verbalizing the route information, and recognizing the initial orientation and direction of the route. Results indicated that WM ($R^2 = .04$, $p = .045$) and PTA ($R^2 = .128$, $p < .001$) were significant predictors of route learning (navigation performance) in the pretest. In the posttest, their impact diminished within the instruction condition but remained consistent in the control condition. While the instructions did not directly enhance performance in the instruction condition compared to the control condition, they effectively decreased the influence of WM and PTA. We interpret this pattern of results as an aptitude-treatment interaction (ability-as-compensator). In conclusion, cognitive instructions can mitigate the effects of individual differences in crucial spatial abilities in specific tasks, offering insights for educational and training interventions in navigational skills. In additional exploratory analyses, we examine reading processes (and changes due to instruction) using eye tracking during the map reading phase.

Self-advantage in the processing of objects in peripersonal space

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We interact daily with objects that are close to us and that we can manipulate. These proximate objects are located in our peripersonal space (PPS), a space that serves as a motor interface between the body and the environment. PPS is thus a space underlying the organisation of voluntary actions and, as such, objects present in this space can spontaneously activate the motor system, as if the organism was anticipating acting on these objects. However, not all objects belong to us and a conflict may emerge between the conceptual and the sensorimotor processing of objects in PPS. In the present study, we analysed the accuracy of reachability judgments of self-owned and other-owned objects presented in PPS or extrapersonal space (EPS). EMG activity was recorded on the right thumbs (flexor pollicis brevis) to detect correct and erroneous motor activations. Behavioural data showed that reachability judgments were faster for self-owned objects in PPS and for other-owned objects in EPS. The analysis of the EMG activity revealed that more errors were initiated in the PPS for other-owned objects and in the EPS for self-owned objects, and that errors were more quickly and more efficiently corrected in the presence of a self-owned object in the PPS. Overall, the data revealed that reachability judgments were faster and more accurate in the PPS for self-owned objects, with more efficient regulation processes in the presence of motor errors. A complementary study using fMRI highlighted the neural networks subtending conflict resolution in the PPS and EPS, while performing reachability judgments about self- and other-owned objects. Altogether, the results confirm the sensorimotor nature of the PPS, enhancing perceptual and motor processing, but underline the specific role of object ownership.

The Role of Spatial Audio Fidelity in the Mediation of Interpersonal and Peripersonal Space in Immersive Virtual Reality

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It is clear from neuropsychological studies that audiovisual stimuli provide essential cues for the mediation of interpersonal and peripersonal space. Particularly, audio stimuli provide aural feedback that aids in the localization of objects in space relative to one's body. In simulated environments, such as those mediated via immersive virtual reality, it is a complex process to generate aural feedback that matches that of the real world. State-of-the-art virtual reality applications currently generate spatialized audio via generalized head-related transfer functions (HRTFs), which simulate aural feedback processed through a generalized ear structure. These generalized HRTFs may affect the way that users of virtual reality simulations localize sounds in these environments, as the filtering of sounds is affected by the unique dimensions of one's head, pinna, and torso. In this talk, we present data from a study in which interpersonal and peripersonal space are measured in an immersive virtual reality environment in the presence of generalized spatial audio. We also present preliminary data collected in the presence of personalized spatial audio. We discuss the implications of the use of generalized HRTFs in relation to object localization in virtual reality environments.

False Navigational Memories: The Influence of Semantic Traces and Meta-Memory

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Retrieved memories of past events are often inaccurate. According to the fuzzy trace theory, this phenomenon may stem from gist-based encoding and retrieval processes, which emphasizes general semantic meaning over specific details, leaving room for mistakes in memory reconstruction. For example, when recalling a list of words associated with one absent critical lure, individuals often erroneously include the lure in their list recollection. During navigation, we store many different types of information to orient ourselves in space. We hypothesize that semantic traces can influence false memories formation also regarding navigational information.
Additionally, we were interested in assessing the effect of metamemory on false memories, expecting that less confidence in one's own mnestic abilities would predict higher false memories susceptibility. In our experiment, after navigating an immersive virtual reality city square, participants in the experimental group were given some misleading questions probing details about some non-existent building in the environment. These buildings varied in their degree of semantic congruence with the typical concept of a city square. The control group were asked questions only regarding present buildings. After 24 hours participants came back to the laboratory and were asked to perform a recognition and a positioning task involving present and non-present buildings.
We assessed episodic and autobiographical meta-memories using the Survey of Autobiographical Memory (SAM) and the Memory Experiences Questionnaire (MEQ) questionnaires. Our analysis, on a sample of 110 participants, showed a strong effect of our manipulation on the number of false recognitions, thus confirming our hypothesis on the role of semantic traces in the creation of false navigational memories. In fact, our misinformation manipulation has been more effective on buildings that were semantically congruent to the concept of a square. Contrary to our expectations, we found a positive relationship between specific types of meta-memory and false memories.

Engaging with three-dimensional virtual characters in augmented reality

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Augmented reality (AR) offers interactive content that integrates real-world and digitally created objects and bodies. AR experiences are often accessed on smartphones and tablets, which afford manual control and embodied virtual experiences. One way to deliver interactive AR content is by volumetric video capturing, where people or objects are turned into three-dimensional interactive figures that users can engage with using AR-capable devices. In these experiences, users can define the figures' position, move closer to or further away from them, and view them from any angle. This paper reports from a behavioral study where participants watched either volumetric or two-dimensional video recordings of people delivering a speech. After engaging in the experience, using survey methods, we measured their sense of sharing a space with the virtual figures as well as the level of emotional engagement and comprehension of the speech's content. Participants also rated how certain user-experience design elements (e.g., fidelity, interactivity, the figure's attributes) contributed to their emotional engagement and comprehension. The findings of this study reflect on the effects of engaging with photorealistic humans in extended reality experiences and the ways in which volumetric capturing of people can impact the sense of realism. It also presents the potential of volumetric video and AR-based communication to enhance the feeling of being closer to others and diminish the sensation of loneliness.

Imagery questionnaire in different time perspectives - psychometric data of the tool

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Motor imagery is a conscious activity of generating or recalling multisensory scenarios in the absence of visual stimuli. Research reveals the mechanism of imagery's effects on behaviour and motivation through emotional responses to the above imagery (Ji, Geiles & Saulsman, 2021, Holmes et al., 2008). However, it is important to control imagery so that it can be used in training (Morris et al., 2005). The time perspectives (Zimbardo, Boyd, 2011) in which an individual functions are correlated with the ability to imagine (Szota, 2021). Higher past negative perspective correlated negatively with internal perspective imaginations. In contrast, past positive perspective correlated positively with imaginings from internal and kinesthetic perspectives. The aim of our study was to create a Polish-English tool to diagnose imaginations in several aspects: the study of imagery skills, which type of imagery prevails (positive, negative or neutral) as well as the aspect of motivation and emotions being associated with imagery. Students at the Universities of Plymouth, Gdansk and Szczecin filled out the Imagery Questionnaire in Different Time Perspectives (a new tool), the Time Perspective Questionnaire, the VMIQ-2 questionnaire and a shortened version of the Big Five Personality Questionnaire. The new tool was tested for reliability (test-retest) and relevance (pre- and post-intervention measurement and comparison with already existing measures of perceptions). Imagery was most closely related to the prospective future. Emotionality was high in all time perspectives. Preliminary results of the questionnaire indicate the reliability of the tool and its ability to measure the consistency of multisensory imagery at two different times 4 weeks apart. The analysis of the questionnaire suggests a single common factor for measuring imagery, but the distinction of subscales may have descriptive and individual significance in the practice of sports psychology.

Should I Stay or Should I Go? Guiding Decision Making at Railway Crossings

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Navigating complex environments requires quick and accurate decision making, including the choice to 'stay' or ‘go’ in crossing situations. Pedestrian-train collisions at railway crossings are a critical concern. These accidents may result from internal factors such as pedestrian distraction, and environmental factors, such as the lack of an effective safety device.
Endsley's (1993) Situation Awareness (SA) model, which posits that individuals construct mental models based on their perceptions of the environment, is often used to explain decision making in complex environments. However, alternative perspectives, such as embodied cognition theories, establish a more direct Perception-Action (PA) link (Varela et al., 1991), suggesting that individuals adapt their behavior to the opportunities offered by the environment (Gibson, 1977), without relying on high-level information processing.
In this study, we confronted these two approaches to determine which was more effective in guiding behavior, using a Stop Signal task. Participants played an online game where they controlled a blue triangle avatar, earning points by moving forward and losing points in case of a collision with an obstacle. To mirror real-world scenarios where pedestrians engage in other activities while crossing, a dual-task paradigm was implemented. Thus, participants were simultaneously solving mental arithmetic problems while inhibiting a moving forward action upon a stop signal.
To assess the level of information required to adopt the correct behavior, we constructed six variations of device concepts rooted in both SA and PA approaches. These variations involved different processing levels to achieve stopping at the right moment.
Results showed that the PA devices, when multimodal (visual and auditive), demonstrated quicker and better responses, suggesting that a deep understanding of the situation may not be essential to adopt the right behavior. These findings may guide the development of optimized safety devices at railway crossings, considering not only engineering aspects but also human cognition.

Paving the way for social touch sonification: behavioral studies and applications in virtual reality

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With the increase of social isolation and distant communication, it appears timely to allow distant socio-affective interactions. To do so, we developed a methodology combining the use of a novel sonification technique that considers skin as a singular sonic texture and prototypical social touch gestures. Three studies explored the feasibility of this technique, its core components, and its potential applications in virtual reality. In the first study, the vibratory signals from prototypical skin-to-skin touches were recorded with a piezoelectric transducer, allowing their conversion into sounds. The resulting sonified signals were presented to participants who were able to accurately categorize both the different gestures (stroking, rubbing, tapping, hitting) and their underlying emotional intentions (love, empathy, joy, impatience, fear, anger). The second study investigated the respective roles of rhythm and textural properties on participants' abilities to recognize social touch through sounds. The same tactile gestures as in the first study were reproduced in two different surface conditions: skin-on-skin and object-on-object. The results revealed that the dynamics of the surface involved in the touch are crucial, and that skin-on-skin interactions bear information that sets them apart from object-on-object movements. The third study was conducted with the platform of virtual agents Greta, which allows simulating 3D touch gestures between the user and the virtual agent. Participants performed a virtual reality game during which they received socio-affective touch from the agent, or not. We then quantitatively investigated participants' perception of the virtual agent depending on their tactile behavior and the emotional intentions conveyed this way. These results pave the way for allowing social touch at a distance, through multisensory channels, with both humans and virtual agents.

Training visuo-spatial working memory in healthy older adults with immersive and tablet-based tasks: preliminary results.

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The efficacy of visuospatial working memory (VSWM) training in aging is still an open issue. They seem to be less effective than verbal ones: the type of stimuli, often meaningless and unfamiliar for older adults, and the less engaging demands, far from real-world requests, of the trained activities proposed (e.g., remembering shapes' positions in matrices) seem to impact the benefits of such programs, especially in terms of transfer effects.
This study assessed, in a sample of healthy older adults, whether a VSWM training entailing the practice on more immersive VSWM tasks that involve also moving in a real-world controlled setting promotes training gains and transfer effects to rotation ability measures.
Therefore, a group of healthy older adults (Trained group) practiced for 6 sessions with variants of two VSWM tasks, the more immersive backward Walking Corsi Test (bWalCT) entailing moving in a larger-scale setting, and the classic backward Corsi Blocks Task (bCBT) presented on tablet. The trained activities required to memorize and recall backwards sequences of squares on a configuration either moving in a larger-scale setting or on tablet, as well as memorizing the sequences presented in the larger-scale setting and then recalling them backwards on tablet, or viceversa. Another group (Active control group) was involved for the same number of sessions in alternative activities. Short-term (pre-post test) training gains were examined with the bCBT and the bWalCT, and transfer effects with the Pathways Span Task (PST), a VSWM measure with different demands than the trained tasks, the Mental Rotations Test and the Object Perspective Test.
Preliminary results showed medium-to-large effects for the accuracy in the bCBT and the bWalCT for the Trained group vis-à-vis the Active control group. Transfer effects were limited. The feasibility of using more immersive VSWM training procedures for older adults seems to be promising.

Taking my perspective or yours? The influence of personality traits, psychopathological traits, and interoceptive abilities

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The ability to constantly alternate between our point of view and someone else's corresponds to a flexibility of perspective-taking present in typical adults. During social interactions, adopting a perspective centered on others is necessary to communicate with them. This ability requires access to our interlocutor's visuo-spatial experience. On the other hand, adopting a self-centered spatial perspective in an egocentric frame of reference, the origin of which is our body, is central to the unity of the self, inherent in bodily self-awareness. These two types of spatial perspective thus correspond to different requirements. How do we juggle between them? The graphesthesia task we developed, in which ambiguous tactile symbols are tactually presented on the body and can be interpreted differently depending on the spatial perspective, allows measuring how people differ in the spatial perspectives they naturally adopt. In addition, it allows investigating people's ability to flexibly change spatial perspectives, a measure that is often neglected by other perspective-taking tasks. In this talk, through three sets of experiments, I will highlight how perspective-taking varies as a function of personality traits (in particular, social intelligence and anxiety), psychopathological traits (schizotypal and autistic), and interoceptive abilities (interoceptive sensibility, cardiac interoceptive accuracy and awareness). Altogether, this research aims at shedding light on the interrelations between spatial perspective taking, social cognition, and bodily self-consciousness.

Exploring Motor and Visuospatial Processing in Developmental Coordination Disorder and Nonverbal Learning Disability: A Comparative Analysis.

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Motor and visuospatial abilities are crucial for children's efficient daily functioning, playing a predominant role in the acquisition of adaptive behaviors and independence. By specifically investigating the motor and visuospatial domains, we can underscore the existence of two neurodevelopmental conditions that frequently display overlapping symptoms, posing challenges in the differential diagnosis process.
Developmental Coordination Disorder (DCD) is characterized by inherent motor challenges frequently accompanied by concurrent visuospatial deficits. In contrast, Nonverbal Learning Disorder (NLD) or visual–spatial developmental disorder primarily involves visuospatial difficulties, with a relatively inconsistent definition of the motor profile.
Remarkably, there has been no study to date comparing the motor and visuospatial profiles of DCD and NLD. This study aims to investigate to what extent DCD and NLD share any common characteristics.
Involving a cohort of 102 participants (DCD N=29, NLD N=29, non-diagnosed N=44) with ages ranging from 8 to 16 years (Mean age=11.80 years, 68.62% male), motor and visuospatial tasks were administered. A direct comparison of performance across the three groups was conducted, and the discriminatory efficacy of motor and visuospatial measures in distinguishing between each group was assessed.
Our findings corroborate the existence of substantial impairments in the motor and visuospatial domains for the DCD and NLD groups, respectively. Overall, motor and visuospatial tasks effectively differentiated children with DCD or NLD from non-diagnosed children, though with specific features for each clinical profile. Notably, Balance (AUC=0.88) and, to a lesser extent, Spatial Processing (AUC=0.74) demonstrated significant predictive power in distinguishing between DCD and NLD.
Our results uncovered similarities across disorders and emphasized distinctive characteristics, underscoring the importance of conducting a thorough assessment of both motor and visuospatial abilities to differentiate between DCD and NLD. The implications of our results are explored in terms of their potential influence on both research and clinical applications.

Enhanced vividness of imagery in aphantasia after exposure to multi-modal stimuli

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Various psychology therapy methods use multi-modal stimuli and associated imagery to improve mental health. While there is a wide research base to suggest that individuals can utilize these stimuli and access imagery, therefore benefiting from such therapy techniques, the research that looks at how people with aphantasia respond to such stimuli and therapy is in its infancy. Specifically, it is unclear whether people with aphantasia can benefit from therapy techniques which rely on imagery.The present study was therefore set to explore whether people with aphantasia alter the rating of their imagery vividness based on prior exposure to various stimuli.
57 participants with aphantasia (age range 18-69; 75% female) rated the vividness of their imagery using the Vividness of Visual Imagery Questionnaire – Modified (VVIQ-M) and the Bucknell Auditory Imagery Scale – Vividness / Control (BAIS-V/C). They also rated the vividness of their imagery using a 7-point Likert scale following exposure to stimuli in visual and auditory modalities (art photography, music, and verbal instructions).
It was found that the stimuli used in this study affected the visual and auditory vividness rating of aphantasics. Specifically, participants reported more vivid visual and auditory imagery after exposure to stimuli in various domains, compared to their rating on the established questionnaires (Wilcoxon's signed rank test, $W=17.00$, $p=0.001$, $rrb=-0.84$, for visual imagery; $W=759.00$, $p<0.001$, $rrb=0.68$, for auditory imagery). We also found an interaction between the modality of stimuli and imagery: visual image had significantly higher impact on the auditory imagery vividness scores compared with music stimuli (Dwass-Steel-Critchlow-Fligner tests, $W=-4.59$, $p=0.003$), and lower impact on the visual scores compared with the verbal instructions ($W=3.55$, $p=0.032$).
These findings suggest that vividness of imagery can be affected by stimuli even in aphantasia, and this provides initial insights for the development of targeted mental health interventions for aphantasics.

The role of sleep in the consolidation of different spatial memory representations

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Consolidation of spatial memory is known to benefit from a retention period spent asleep. However, it is still unclear whether sleep differentially facilitates consolidation of spatial information in the different spatial reference systems (SRSs: egocentric, allocentric, intrinsic). In addition, studies have mainly employed motor tasks, in which motor and spatial components of performance are difficult to disentangle. Here we investigate the effect of sleep vs. wake on the consolidation of visuospatial learning through the Judgement of Relative Direction Task (JRD). Two groups of healthy adults were administered the JRD before and after an 8-hour retention period spent awake (N = 16, 8 F, Mage = 24.1 ± 2.60) or asleep (N = 13, 5 F, Mage = 27.1 ± 3.23). The JRD consists in learning a 7-letter layout on the floor, followed by the administration of 48 trials (e.g., “You are standing on A facing E: where is D?”), divided in three blocks (one per each SRS) in balanced order between-subjects. Analyses revealed increased accuracy on both allocentric (U = 54, p = .028, rrb = .481) and intrinsic (U = 37, p = .003, rrb = .644) trials in the Sleep compared to the Wake group. In addition, the Sleep group showed higher speed in intrinsic trials than other conditions (t(27)= 2.2467, p = .033, Cohen’s d = .8389). In line with previous studies employing motor tasks, our findings show that sleep promotes allocentric over egocentric components of spatial memory at a visuospatial task. Furthermore, this is the first evidence of a sleep effect on the intrinsic component of spatial memory, providing indirect support to Mou and McNamara’s intrinsic reference theory (2002).

How do different map formats influence the perception of space-time and route choices on a geographical scale?

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Humans can mentally represent their surroundings based on navigational experience, but extended spatial scales, like cities or countries, require abstraction into maps (Montello, 1993). Maps prioritize conveying specific information, often at the expense of other properties (Denis, 2017). For instance, graphically depicting temporal durations for road journeys requires transforming spatial relations. Conversely, accurately showing spatial kilometric lengths of journeys may not convey travel time information, especially when speed variations are involved (Spiekermann & Wegener, 1994). Designed to tackle this problem of geographical space-time mapping, "Shrivelling maps" are a tridimensional cartographic model designed to preserve the spatial location of places while drawing information about temporal durations in multimodal transportation networks (L'Hostis, 2009). Yet, their practical utility requires further evaluation: can they be efficiently processed by humans and used as an innovative tool for route planning?

This study examines how various map formats influence human perception of spatial and temporal dimensions on a geographic scale. Three independent groups were introduced to different map formats: emphasizing travel times (anamorphic), travel distances (topographic), or potentially both (shrivelling). Participants then chose optimal routes based on shortest spatial kilometric length or fastest temporal duration, with accuracy and response times recorded. Hypotheses were that topographic maps would facilitate spatial estimations, while anamorphic maps would enhance temporal estimation. Shrivelling maps were expected to yield intermediate accuracy for both temporal and spatial judgments, but longer response times due to reduced familiarity. Results generally supported these expectations, except for a temporal bias observed with the shrivelling maps, favouring the fastest temporal route even when estimating shorter spatial lengths. This study illuminates how cartographic representations affect cognitive processing of time and space (Prabhakar et al., 2024), highlighting the potential of innovative designs for large-scale route planning in multimodal networks.

Awareness of statistical learning in a large-scale virtual environment

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Efficient environmental search is an important and adaptive everyday skill. A particular question of theoretical interest is whether large-scale search is informed by the spatial statistics of an environment, although the precise factors that modulate sensitivity to spatial contingencies remain unclear. We examined whether sensitivity to, and awareness of, a statistical cue was modulated by the spatial reference frame in which the target was cued. In a fully immersive virtual environment, participants were required to search for a target (a coin) positioned on the ground within an 8 by 8m arena. A target was present on each trial, appearing within the cued quadrant on 50% of trials. Participants completed the experiment within a visually detailed environment (i.e., a naturalistic setting). Once the experimental trials were complete, participants were asked to paint the floor to indicate where they thought the target was more likely to appear. When participants had uninterrupted access to egocentric and allocentric information, they were able to adapt their search in response to the probability cue. However, in contrast to previous findings, participants were unable to respond to the probability cue when the target was cued in only allocentric or egocentric coordinates. Participants were also inconsistent when indicating their awareness of the probabilistic manipulation. Findings demonstrate the binding of spatial statistics to a large-scale space is reliant on access to both egocentric and allocentric information. We discuss the implementation of novel methods assessing awareness of statistical contingencies and further factors that remain to be accounted for in the field.

Analysing 3D sketch maps (talk submission)

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Sketch maps are informal drawings of spatial environments used to externalise one's mental representation of space. Since they are predominantly drawn on paper, sketch maps tend to ignore the vertical dimension of the environment, e.g. by representing spatial relations of city elements top-down. However, sketch maps can also be used to represent vertically-complex experiences, such as exploring a multi-level building or flying around an open environment. Since untrained laymen are usually not able to represent complex 3D spatial relations on 2D paper, the interpretability of such sketch maps is poor. A potential solution to this issue is Virtual Reality technology that makes it possible to quickly and intuitively draw 3D sketch maps by the means of mid-air drawing. This presentation tackles the problem of extracting information about complex 3D structures using 2D and 3D sketch maps, their comparability, and the lack of methods for analysing 3D sketch maps. We report on a series of recently conducted experiments where participants were asked to either explore multi-floor buildings or fly through 3D cityscapes in Virtual Reality. They were then asked to produce paper-based 2D and Virtual Reality-based 3D sketch maps of their routes. We compare 2D and 3D sketch maps using a standardised analytical framework assessing qualitative spatial relations between objects contained in the sketch. Two levels of analysis focused on: (a) participants' ability to represent given spatial relation (which is particularly challenging when 3-dimensional spatial relations need to be presented on a 2-dimensional paper); (b) participant's correctness in representing those 3D spatial relations that were omitted in their 2D sketch map. Our findings suggest that participants struggled to accurately represent complex 3D structures in their 2D sketch maps.

How a tool or an elongated virtual arm influence space and body representations

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This research investigated the relationship between spatial (Peripersonal, Arm Reaching Space) and bodily (Body Image, Body Schema) representations in the context of action-induced plasticity. While Body Image refers to conscious perception of body structure, Body Schema concerns dynamic representation of the body parts. Both, under certain circumstances, show plastic properties. Similarly, Peripersonal Space, the area close to the body where interactions with external stimuli can occur, shows plasticity through spatial remapping induced by tool use. Moreover, Arm Reaching Space shows both similar and different characteristics to the Peripersonal Space, suggesting that their plasticity may depend on different mechanisms. Here, leveraging immersive virtual reality, we compared spatial and bodily representations before and after using tools or elongated arms. We assessed whether or not these representations were selectively modulated. If long arm affected only bodily representations, while tool affected only spatial representations, then plasticity could be selectively attributed to the change in either spatial size or bodily size. Conversely, if tool use and long arm use affected both spatial and bodily representations, then we could conclude that tool was incorporated into the bodily representation as if it were a long arm. Results revealed that elongated arm use extended the arm length in Body Image. Both tool and elongated arm lengthened Body Schema, with the elongated arm having a greater influence on the elbow-wrist segment. Peripersonal Space extended after both usages. Arm Reaching Space only increased after elongated arm, suggesting that it is more linked to body than space representation. Body Schema and Arm Reaching Space appeared to be more body-related, whereas Peripersonal Space and Body Schema revealed a more complex nature. Theoretical implications will be discussed.

Developmental Topographical Disorientation: Further theoretical framing and a possible link to aphantasia

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Developmental Topographical Disorientation (DTD) was first documented in 2009 and refers to the frequent experience of getting lost, in the absence of any neurological, psychiatric or other cognitive disorders or impairments. The instances of getting lost in DTD primarily have been suggested to rely on an absent ability to imagine spatial features of environments. To date, DTD is determined by qualitatively verifying its criteria. Recent developments in navigation assessment allow us to explore quantitative diagnostic tools for DTD. In this presentation we combine a literature review with new experimental data of a single case and a sample of participants with DTD.
15 publications on DTD have been analysed in terms of which aspects of navigation were included in measurements and which were impaired. A distinction was made between landmark knowledge, egocentric and allocentric location knowledge, and static (survey) and dynamic (route) path knowledge. A clear pattern emerges for most studies, in which landmark knowledge is intact, egocentric location knowledge is typically omitted, and allocentric location as well as path knowledge are typically impaired. This performance pattern is in line with the suggested impairment in spatial imagery. A single case study as well as a group study (N=12) allows us to analyse navigation performance on the Wayfinding Questionnaire, Leiden Navigation Test and the Virtual Tübingen Test as well as qualitative interviews. Results indicate that the Wayfinding Questionnaire is highly effective to detect DTD, as all participants show impaired scores on the subscale Navigation and Orientation. Furthermore, landmark knowledge is relatively intact and often used as a compensatory strategy. For the other navigation domains, performance is mixed. Interview outcomes support the possibility that DTD may be considered ‘spatial aphantasia’, in which objects can be imagined without problem, but spatial features, including 3D line drawings are substantially limited.

Motor performance as a function of compromised motor imagery ability in individuals with Down Syndrome?

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Due to a genetic predisposition, people with Down syndrome (DS) show limitations in mental, linguistic, and motor development. One facet of impaired motor behavior is impaired motor planning ability, which is thought to be related to an impaired ability to use motor imagery (MI, perceptual process through which people plan, initiate, and control their actions). Numerous studies have investigated motor imagery in typically developed individuals (TD), but this issue has been neglected in people with intellectual disabilities. This study aimed to determine the relationship between motor performance and MI ability in individuals with DS compared to typically developing (TD) children. Twenty adolescents and young adults with DS (20.0 ± 4.62 years, 50% female) and 20 TD children (matched for mental age; 9.00 ± 1.75 years, 40% female) completed a modified version of the Test of Controllability of Motor Imagery (Schott, 2013). Motor performance was assessed using the Canadian Agility and Movement Skill Assessment (CAMSA; Longmuir et al., 2017). MANOVA revealed significant differences in CAMSA total score and distribution scores between the two groups (DS vs TD (Wilks' Lambda=.473, $F(3,33)=12.3$, $p<0.001$, $\eta 2p=.527$), with TD children performing better than the DS group. The same applies to the ability to imagine movements (Wilks' Lambda=.695, $F(2,34)=7.46$, $p=0.002$, $\eta 2p=.305$). In the TD group, a significant positive correlation was found between motor imagery ability and motor performance ($r=.448$, $p=.047$). In the DS group, however, no significant correlation existed between motor imagery scores and motor performance ($r=.131$, $p=.478$). In conclusion, the current study suggests that individuals with DS have a weaker facilitation effect of motor imagery ability on motor performance. Thus, our findings have important clinical implications for more targeted interventions to improve movement imagination skills as a prerequisite for motor skill learning in individuals with DS.

Neural correlates of task proceduralisazation and motor simulation in "good" and "poor" motor imagers. A functional near-infrared spectroscopy study (fNIRS)

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Following instructions is crucial for flexible adaptation in motor learning contexts. Converting instructions from a declarative to a procedural format enables success on the first attempts at performing a task. The proceduralization of instructions may be based on anticipatory motor simulation (Palenciano et al., 2021). This study aimed to investigate whether interindividual variability in motor imagery (MI) ability results in cortical activation differences between motor imagery and motor execution, using functional near-infrared spectroscopy (fNIRS) after a series of instructions. Fifty participants (64% female, mean age 22.5 ± 3.52) were divided into two groups based on their MI ability. The study assessed cortical activation using functional near-infrared spectroscopy (fNIRS) with 16 sources and 16 detectors. Participants performed the Test of Controllability of Motor Imagery (CMI, Schott, 2013), an objective test of MI ability. Participants were provided with a description of a movement sequence comprising of five instructions and were instructed to imagine the sequence without physically performing it. The participants then had to produce the final body position as quickly as possible. Results showed that motor execution resulted in higher activation levels, faster response times, and a different spatial distribution, particularly in the prefrontal cortex, compared to the motor imagery condition. In addition, the study found that poor MI performers exhibited increased hemodynamic responses in all defined regions of interest compared to good MI performers, which supports the assumptions of the neural efficiency hypothesis (NEH). Both groups showed stronger left-sided activation patterns in the execution condition but not in the imaginary condition. The results suggest that verbal instructions can trigger automatic effects on behavior through procedural representation, but only for individuals with good MI ability. Further research could explore the role of mental practice in constructing procedural representation based on instructions, given its potential benefits in sports, neurological, and orthopedic rehabilitation.

The impact of proactive attentional control on braking and lane keeping: a simulator study on driving performance

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Driving, akin to visual search, robustly hinges on enhancing the selection of driving-relevant objects (i.e., other cars, pedestrians, traffic lights) and on filtering out interfering distractors (i.e., billboards). Psychophysical findings have consistently observed that this filtering mechanism is applied proactively in contexts where distracting events are highly probable. However, visual search data has also made it clear that this mechanism comes with both benefits and costs, modulating responsiveness and accuracy even when distractors are temporarily absent. In the current study we aim to investigate how the unfolding of proactive control processes modulates performance in a more ecological context, i.e., during a simulated virtual driving task, by employing an adapted version of the Distractor Context Manipulation (DCM) paradigm. Within a driving simulator, participants (N = 24) were deemed to stay on track and quickly press the brake pedal when a task-relevant road sign-like target appeared. They were tested under three different conditions: a Pure Block with no distractors, and two Mixed Blocks, characterized by the frequent presence of irrelevant distractors (67% of trials) of different perceptual complexity (Feature Search vs. Conjunction Search). We found that in Mixed Blocks – compared to the Pure block – the recruitment of proactive control mechanisms for distractor expectation caused a delay of braking responsiveness in distractor-absent trials, an effect whose magnitude was a function of the visual search's complexity. On the other hand, the same mechanism produced a general increase in lane-keeping performance when neither targets nor distractors were presented. Comprehensively, our findings prompt the thought-provoking possibility that maximizing road predictability by removing any potential distractors may even compromise safe navigation, particularly in driving scenarios where proactive control processes are more beneficial than costly. Accordingly, our data may be of promising informativeness to policymakers applying pragmatic, evidence-based interventions to enhance safe driving.

Body Swapping in Virtual Reality: Reshaping Boundaries Between Self and Others to Enhance Interpersonal Trust

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Cognitive and neuroscientific research has revealed the malleable nature of the self-other boundary, positing that this boundary can be dynamically reshaped through manipulations of body ownership. While prior studies have demonstrated that embodied experiences in virtual reality (VR) foster positive interpersonal associations, these studies have largely relied on avatars categorized by simplistic, overt characteristics such as race and gender. This method overlooks the complex nature of individual self-narratives and the nuanced dynamics of social identities.

Addressing this gap, we pose the research question: Can body swapping in a VR environment between two strangers lead to a redefinition of self-other boundaries and, as a result, enhance interpersonal trust? Furthermore, our study examines whether any changes in mutual trust remain evident for one week post-experiment.

Using frontal photos and body measurements, we created virtual avatars closely resembling participants' appearances and physiques. Through body tracking and IK control, participants could control and experience both their own and others' avatars, offering a novel way to explore self-other boundary manipulability.

We measured the effects of this VR body-swapping experience by assessing participants' performance in an economic trust game and analyzing their responses to a detailed survey. These instruments are designed to capture shifts in expectations of social behavior, recognition of the complexity of others' social identities, and insights into the motivations behind trust formation.

This study seeks not only to enhance our understanding of how virtual experiences influence real-world perceptions and behaviors but also to illuminate VR's potential as a tool for boosting empathy and trust. By examining the impact of VR body-swapping on redefining self-other boundaries and trust, our research offers novel insights into the flexible nature of social identity and interpersonal relationships.

Hide and Seek: The influence of role and mentalising on exploratory behaviour

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Hide and seek is played by human and non-human species the world over, and it is considered a safe and controlled context for honing important survival skills. Recent studies suggest that both search and concealment rely upon similar representations, although other theories posit that hiding requires additional social cognitive processes such as perspective taking. To explore this further we devised a novel desktop virtual reality paradigm that required participants to engage in a game of hide and seek with another player. Participants played both roles in separate blocks and were required to either hide from their opponent, or to seek them, in one of two locations. Their computer-controlled opponent either searched, or hid in, one of those locations on 80% of trials, allowing for an assessment of the decisions underlying player behaviour. To examine the role of mentalising we also manipulated whether participants assumed the agent was artificial (Experiment 1) or controlled by an adjacent participant (Experiment 2). Following the hide and seek game participants completed a measure of perspective taking ability (the Director Task). Playing with another agent seemed to induce complexity when learning the simple statistical regularities – across both roles, and both experiments, participants developed sub-optimal strategies, although they tended to ensure greater payoff than the other agent. When seeking, participants showed more reliance on their own decision history, whereas when hiding they relied more on the other agent's decision history. When the presumed opponent was a computer, they tended to imitate using the previous trial, but when the presumed agent was a human, they instead relied on temporal trends. Perspective taking ability was unrelated to any behaviours, as indicated by no associations with the Director Task. Our results suggest that hiding is more influenced by the choices and presumed mentalizing complexity of another agent than seeking.

Preventing dementia using go4cognition

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Mild cognitive impairment reflects an intermedia state between cognitive decline during normal aging and dementia. It is known that 10% of all subjects with MCI will develop dementia. 120 volunteers were scanned for fulfilling the criteria of MCI using the CERAD total score. 30 subjects who met this criterion received a 6-week 2 hours / week training with the newly developed tool go4cognition in a group setting. 8 stations equipped with a tablet were placed in the training room. Subjects were equipped with a baton including a microchip to record responses and response times at each station. Post intervention evaluation could show that 70 % of all participants did not meet the criterion of MCI after the intervention. Results could clearly demonstrate a training-related performance improvement after only 6 weeks of intervention. The usage of the go4cognition tool in other patient groups e.g. after brain injury will be discussed.

How does attending virtual art exhibitions influence creative behavior?

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Many previous studies have confirmed the positive impact of the use of virtual reality (VR) on creative behavior. In this study, we examined whether such an effect occurs with exposure to virtual art environments. Specifically, we examined whether participation in VR art exhibitions that are virtuality-based (i.e. without real-world equivalents) via various media leads to creative performance in non-art tasks, in any specific creative domain and outside the virtual environment. In this study, we identified creative behavior with the perception of non-canonical affordances and operationalized it in terms of the number of unusual responses regarding the uses of directly perceived objects. A total of 162 young adults participated in the study and were assigned to three conditions: an active VR condition, a passive VR condition (watching recordings of an active VR condition), or a no-VR control condition. We found that people actively participating in virtual art exhibitions gave more atypical responses – and therefore perceived more non-canonical affordances in the objects – than both people in the passive VR condition and the control condition. These findings contribute to positive cyberpsychology by confirming the beneficial effects on everyday creativity of people using VR technology.

Heuristic-based errors during intuitive spatial reasoning.

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Previous research has demonstrated intuitive reasoning can involve heuristics that produce systematic errors in judgement (Kahneman, Slovic & Tversky, 1982; Lejarraga & Hertwig, 2021). One potential source for such misleading intuitions is attribute substitution, where individuals confronted with solving a difficult problem reimagine it as a simpler version without any explicit awareness of the substitution (Kahneman & Frederick, 2002). While much research has focused on heuristic-based errors in relation to statistical reasoning, the field of intuitive spatial reasoning has been less extensively explored (Haugland, Pearson & Ekroll, 2021).

This presentation will discuss two studies that have examined the occurrence of heuristic-based errors during intuitive spatial reasoning. In Study 1 261 participants were presented with a Möbius band and asked to predict the consequences of cutting along the middle of the band all around the loop. Although such an operation produces a single unbroken loop, 80% of participants incorrectly predicted the cut would produce two separate pieces. In Study 2 (Ekroll, Frøslie, Johansen, Sætre & Pearson, in preparation), 176 participants were asked to solve variations of the “rope-around-the-earth" puzzle (Arcavi, 2003) in which the size and/or shape of the central object were manipulated. The majority of participants strongly overestimated the correct answer, with the largest error five million times larger than the correct value.

The results of both studies will be discussed as characterising “illusions of imagery” (Ekroll, 2019). For both the Möbius band and rope-around-the-earth puzzle the majority of participants are unable to accurately simulate the required actions, and instead rely on intuitive spatial heuristics that lead them to erroneous solutions.

Online vocal exchanges about abstract concepts foster automatic imitation between young conversational partners

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Abstract concepts are learned, mastered and used through dialogical exchanges (Borghi et al., 2017, 2018, 2023; Fini & Borghi, 2019; Banks et al., 2023). To examine whether a brief vocal exchange would influence interpersonal dynamics between individuals, we recruited 32 young and 32 older adults (matched for gender and age) to engage in virtual vocal conversations, starting from either abstract or concrete topics. While the conversational topic did not affect the sense of closeness, as measured by a Visual Analogue Scale (VAS), it did influence imitative response tendencies assessed through the finger-tapping task (Brass, 2001). Specifically, following verbal exchanges about abstract topics, young participants exhibited enhanced sensitivity (increased imitative responses) to the hand movements of their conversational partner in the finger-tapping task. However, this effect was not observed among older participants. Additionally, overall bodily activation was greater among older individuals following the conversation, with both age groups showing increased activation in internal bodily parts. Notably, conversing about abstract concepts resulted in increased bodily activation, as evidenced by the bodily activation maps (Nummenmaa, Glerean, Hari, & Hietanen, 2014). These findings support the intrinsic social-linguistic component of abstract concepts (Borghi et al., 2017, 2023; Fini & Borghi, 2019). Previous research has demonstrated increased movement synchronization after engaging in abstract concept interactions (Fini et al., 2020). Expanding on this, after virtually conversing about abstract concepts, participants exhibited increased imitation of each other, although this effect was not observed among older adults, who exhibit lower embodiment (Costello & Bloesch, 2017). Moreover, interpersonal distance, a more explicit measure, remained unaffected by conversational topics. In conclusion, the abstractness of conversation topics impacts social dynamics in an age-dependent manner: young adults seem to bodily resonate more with others when talking about abstract concepts.

Attentional Selection, suppression and visual working development

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Visual working memory (VWM) improves from childhood to adulthood yet the factors driving this improvement remain under investigation. While past research has shown that neural efficiency in deploying selective attention is positively related to VWM performance over development (Shimi, Nobre, & Scerif, 2015), the role of behavioural and neural differences in inhibition and suppressing distractors has not been explored. This talk presents new data from two studies, a behavioural study examining the links between selective attention and inhibition in children with attentional difficulties and an ERP study examining the neural activity involved in target selection and distractor suppression as they relate to VWM. In the behavioural study, participants completed a task assessing selective attention in service of visual working memory and a task measuring response inhibition. In the ERP study, participants completed two new tasks; one requiring selective response to a target while ignoring a distractor, and one requiring recognition of a probe from a previously presented memory array. Results from both studies shed light on the mechanisms constraining VWM capacity over development in typically- and atypically-developing children.

Virtual Reality to assess Episodic Memory in AD and aMCI patients: The Role of Emotional Variables

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One of the hallmarks of early clinical stages of amnesic mild cognitive impairment (aMCI) and Alzheimer's disease (AD) is episodic memory (EM) impairment. Episodic memory refers to the ability to retrieve an autobiographical memory of events that occurred in a particular spatial and temporal context. However, most classical neuropsychological tools provide an EM assessment far from what is commonly experienced in daily life. Moreover, most research focuses on evaluating cognitive functions without taking into account emotional variables, which are strictly connected with memory.

The present study aims to assess episodic memory in AD, aMCI patients and healthy older adults using a virtual environment, thus more similar to everyday life. Secondly, the study aims to determine whether emotional factors (neutral, positive or negative variables) can influence encoding and therefore memory performance in pathological ageing.

The protocol requires participants to explore a virtual environment, created using software called CoSpaces Edu. The pathway navigation is set on an egocentric perspective: participants watch the scene move at a fixed pace along a road and they have to remember the objects they find on the way. Three different conditions are used: objects to remember are placed next to human characters which show neutral (i), positive (ii) or negative (iii) emotions. Each participant explores two virtual environments, the neutral and the positive or negative emotions environment, randomly assigned. A free recall and a visual recognition task are presented at the end.

Preliminary results reveal the advantage of using a virtual environment for EM assessment over classical neuropsychological tasks in all samples of the study. Moreover, emotions show an influence on participants' EM; positive emotions appear to enhance patients' performance, consistent with the "positive effect" reported in the literature.
Future developments could exploit this virtual environment not only for assessment but also for rehabilitation and therapeutic purposes.

The interaction between parenting style and cortisol levels on emotional words processing in primary school children: an ERP study

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Previous literature suggests that emotions may substantially influence words processing, at both behavioral and neurophysiological levels. With regard to the latter, the N400 component, which is associated with the processes of lexical access and semantic and contextual integration that occur during reading, may be modulated by emotional valence. However, only few studies investigated neurophysiological correlates of this phenomenon in children. Moreover, little is known on the biological and/or environmental factors that may modulate the neural processing of emotional words in children.
Our study aims to investigate the effect of emotions on word processing and its related neurophysiological activity in primary school children and the potential impact of cortisol levels and parenting style. To achieve this, we used electroencephalography (EEG) with an event-related potential (ERP) approach, focusing on the N400 component.
Forty primary school children aged 8-9 years have been recruited. In this sample, in addition to neurophysiological and behavioral data during a word-processing task, information about cortisol level, parenting style and individual emotional characteristics, were acquired by saliva samples, self-administered questionnaires and standardized tests, respectively.
Preliminary results show that in primary school children N400's amplitude of occipital and frontal areas related to words with a negative valence is affected by the interaction between cortisol levels and parenting style. More in detail, in the presence of a parental style characterized by indifference, N400 amplitude increases in children's occipital areas having high cortisol levels while decreases in their frontal areas in correspondence of low cortisol levels.
The occipital and frontal areas are typically related to stimuli valence's elaboration (respectively in terms of arousal evaluation and regulation) and this finding shows how their function during word processing may be modulated by the interaction between parenting style and cortisol levels.

The effect of motor simulation on spatial construction

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Spatial construction involves the ability to reproduce spatial patterns by organizing details into an integrated spatial configuration, as in drawing and building blocks. Neurofunctional and behavioural data suggested that motor simulation processes play a role in spatial construction, with evidence that mere observing a geometric stimulus can activate motor simulation and re-enactment of drawing actions. On the other hand, some studies have suggested a positive relationship between verbal and constructional abilities, although conflicting results emerge regarding the effect of verbal interference when performing two- and three-dimensional construction tasks. Here, we tested the effect of motor (tapping) and verbal (shadowing) interference on mental construction task. To this aim, 114 healthy right-handed adults were administered a modified version of the Block-design task (BDT), asking them to indicate the only figure among the alternatives that, when reassembled, reproduced the target figure (observation-only condition), while simultaneously performing irrelevant finger tapping (motor dual task condition) or listening to irrelevant verbal material that they had to keep track of (verbal dual task condition). A 2 x 2 x 3 mixed ANOVA was performed on BDT accuracy, with Perceptual cohesiveness (high/low), Uncertainty (high/low) and Segmentation (high/low) as within-subjects factors and BDT Condition (observation-only, motor interference, verbal interference) as between-subjects factor. The main results showed a significant difference between the observation-only condition and the motor interference condition, with higher accuracy in the observation-only condition, and between the motor interference condition and the verbal interference condition, with higher accuracy in the verbal interference condition; no significant interaction was found between the BDT conditions and global/local stimulus processing features, i.e., perceptual cohesion, uncertainty and segmentation. These findings suggest that motor simulation processes are involved in mental construction, and that these processes are activated only after the mental representation of the image is formed, guided by representational spatial skills.

Cognitive Load in Egocentric-Allocentric Switching Processes: a Pupillometry Study

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The position of objects around us can be encoded according to an egocentric (object-to-body spatial relations) and/or allocentric (object-to-object spatial relations) reference frame. Usually, egocentric coding requires less effort than allocentric coding because the body is the primary interface between individuals and environment. However, during most everyday tasks, we continuously switch from a body-centred to an object-centred spatial representation and vice versa. It has been shown that switching between different tasks involves a considerable cognitive load, however, this has not yet been demonstrated for switching processes between spatial reference systems. In the present study the cognitive load related to visuo-spatial switching processes between egocentric and allocentric reference frames has been measured by means of cognitive pupillometry. Specifically, participants had to memorize triads of geometrical objects. Afterwards, they provided two spatial judgments on the same triad in two different conditions: non-switching and switching. In the non-switching condition both spatial judgments regarded the same reference frame: egocentric (i.e. object X closest to you?) or allocentric (i.e. object X closest to object Y?). In the switching condition if the first judgment was egocentric, the second was allocentric (or vice versa). Participants' pupil dilation variations were measured during the task. In line with the literature, a greater pupil dilation in switching compared to non-switching conditions emerged. More importantly, the switching judgments from allocentric-to-egocentric representations were associated with a greater pupil dilation compared to switching judgments from egocentric-to- allocentric ones. This suggests that starting from an allocentric reference frame leads to a higher cognitive load than starting from a stable body-centered anchor point. In summary, these results support the idea that during visual-spatial switching processes the cognitive load varies depending on the anchor point/reference system from which one starts.

GENERALIZATION FROM EPISODIC EXPERIENCE TO SEMANTIC KNOWLEDGE THROUGH THE EXTRACTION OF OBJECTIVE REGULARITIES

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The constant extraction of regularities from episodic experiences transforms them into semantic and conceptual memories that allow us to organise knowledge into cognitive maps. However, previous studies have mostly investigated conceptual knowledge that has already been consolidated. Here we investigated the transformation process of new contextual information into generalized and decontextualized knowledge. We also aimed at identifying the regularities used in this generalization process and describe the topology of the resulting map. We recruited 20 participants who watched a TV series and performed a semantic task quantifying the relationships between pairs of TV series' characters on a horizontal line. Meanwhile, we constructed a social matrix of the characters running an algorithm that considers the number and the type of interactions between the 16 characters (giving more weight when two characters appear in the same scene interacting and less weight when one of them mentions the other without being physically together). We then performed a Mantel Test to determine the similarity correlation between the objective (generated by the algorithm) and subjective (generated from the participant's semantic judgement) social matrices. Then, we transformed the objective and subjective matrices into two graphs where the characters were the nodes, and the relations weights were the edges. We used centrality measures to determine qualitative differences between objective and subjective social maps. We found a significant similarity correlation between the objective and subjective matrices ($r=0,73$; $p<0.001$). Qualitatively, respect to the algorithm the participants overestimated the relationships between the characters and the degree centrality of the 3 characters that appeared last. Our results show that the ability to infer abstract and decontextualized information from experience is based on the accumulation of new episodic information as spatio-temporal co-occurrences. Furthermore, the map topology reveals the presence of cognitive biases not captured by the objective algorithm.

Visual and auditory cueing direct visual predictions in immersive embodied locomotion

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Everyday tasks such as driving, and cycling, involve continuous predictions to fulfil the requirements of situation awareness. In these tasks, it is common for people to use predictions to address visual occlusion events or moments when information is out of sight as a result of human embodiment and natural locomotion. While the visual system is efficient in predicting small-scale visual actions (i.e. saccades), it is unclear how predictive vision generalizes to complex tasks that involve multimodal stimuli (i.e., visual and auditory cues) and large-scale visual actions (i.e., head and body movement).

Here, we test whether visual and auditory cues can set predictions for the visual system and if these predictions facilitate perceptual judgment across head turns and anticipatory gaze during continuous embodied activities. We test this hypothesis in two VR studies where participants (N=40) naturally drive or cycle in an urban environment, while addressing incidents such as overtaking, occluded pedestrians, turns with limited visibility, etc. Study 1 focuses on visual cueing in occlusion events during driving, and Study 2 examines the effect of auditory cueing on anticipatory attention during overtaking incidents while cycling. We analyse multimodal data including gaze, head movements, steering and braking.

The analysis, currently in progress, suggests that visual cueing leads to an increase in fixations on areas-of-interest (AOI) where information is expected to emerge, adjusted head movements towards these AOI, and better reaction times in target detection and driving. Similarly, auditory cuing appears crucial for anticipatory attention, with gaze systematically directed towards the cue even when it is out of sight. Taken together, we present preliminary outcomes showing how small directional biases in gaze and head movements can be achieved with visual and auditory cueing and the effect both cues have on facilitating rapid predictions across large-scale visual actions directly connected to the embodied visuo-locomotive experience.

Finding your way in a bubble is easier, if you can visualize it

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Navigation towards a goal in previously unknown environments likely involves storing and replaying sequences of relevant spatial information. Previous studies on spatial memory adopted “cartography” paradigms in which subjects, typically moving in 2D, could remember and then rely on salient cues, such as landmarks or orientation cues. Little is known about navigation in curved environments with minimal salient information. The present project investigates such a capacity in a sparse, spheric, three-dimensional virtual reality environment that lacks salient landmarks and orientation cues. This environment is created by projecting a dodecahedron onto a sphere where each face differs in color, providing basic spatial reference. In one condition, participants can move in space in all directions. In another condition, participants are anchored to the sphere’s surface, mimicking terrestrial movement in real life. After the spatial memory task, the participants’ spatial imagery, object imagery and verbal abilities were assessed by a self-report questionnaire. Results show that performance was similar regardless of movement type. However, slower individuals, and those who scored higher in spatial and object imagery in the questionnaire, performed significantly better in the spatial memory task, while better verbal skills anti-correlated with spatial memory in female subjects. These findings suggest that taking time to encode spatial information, as well as individual differences in cognitive abilities are crucial in spatial memory tasks, perhaps because imagery skills facilitated the participants’ ability to form mental maps of the spherical environment and keep track of their position relative to the changing perspective.

Exploring the Dynamics of Postural Stability During Egocentric Mental Rotation Tasks with Multi-Axial Figure Rotations

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Mental rotation refers to the ability to visualize objects being rotated within the mind. A particular kind of mental transformation is the egocentric transformation. In testing this, a single figure is typically presented, distinguished by a prominent side feature. Participants are then tasked with determining whether this feature is on the right or left side. It is posited that in such transformations, the relationship between the observer and the environment is characterized by the observer envisioning themselves rotating within the environment to accomplish the task. Given the established connection between mental and motor rotations, as well as the association between mental rotation ability and an individual's postural stability, this study investigates whether the trajectory of the so-called center of pressure, a marker of postural stability, varies while performing egocentric tasks that involve figures rotated around the longitudinal or sagittal axis. To this end, center of pressure parameters are measured while participants stand on a force plate (AMTI OR6-2000, 1000 Hz), engaging in a within-subject dual-task design that includes solving various egocentric mental rotation tasks featuring human figures as stimuli. Statistical analysis is conducted using a Bayesian repeated measures ANOVA. A maximum sample size is estimated using G-Power (N = 109), but the study will employ adaptive sampling based on Bayes' factors. The study will be preregistered at osf.io, and at least preliminary data will be shared at the onset of the conference. Insights from this study will enhance the understanding of the motor processes involved in mental rotation and underscore the significance of embodiment in this relationship.

From copying to retrieve from memory: exploring similarities and differences in the visuospatial and motor predictors of the performance in the Rey-Osterrieth Complex Figure Test

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Deepening the understanding of predictors in complex visuo-constructive tasks is crucial due to their significant role in children's daily activities. Previous reports suggest the fundamental contribution of different abilities to Rey-Osterrieth Complex Figure Test (ROCFT) performance.

The present study aims to examine the role of visuospatial and fine-motor abilities that may differently underlie the performances in the ROCFT copy and retrieve from memory trials, considering also possible related age and sex effects. Visuospatial measures, ad hoc devised for the study, comprised visuo-perceptual skills, mental rotation, and spatial imagery. Graph-motor coordination and two tasks of manual dexterity (i.e., demanding lower or higher executive control) were assessed as motor abilities.

A total of 207 participants (106M and 101F), aged between 6 and 14 years old [(Mage=10.97 (1.80)] were recruited. None of the participants had neither a diagnosis of neurodevelopmental disorder nor of visual or motor impairment. To identify the predictors of the performance in the ROCFT, two linear models were run, having respectively the score in the copy and retrieve from memory trial as the dependent variable (DV), while visuospatial and fine-motor scores, as well as age and sex, were entered as predictors.

Predictors accounted for 39% and 37% of the variance, alternatively, for the models having the ROCFT copy and retrieve from memory trial as DV. Spatial imagery and the manual dexterity task demanding higher executive control emerged as significant predictors in both models. Mental rotation and graph motor skills were significantly related to the score in the copy trial, while age emerged as significant for the recall trial.

Differences in the predictors associated to the copy and retrieve from memory performances were observed. Results may inform both research and clinical practice: future directions involve extending the study of the visuospatial and motor predictors here considered to populations with neurodevelopmental disorders.

Imaginary Weightlessness: Using Mental Imagery to Simulate Microgravity Effects on Weight Perception.

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Introduction. This study explores the impact of mental imagery on mimicking the cognitive effects associated with microgravity, compared to a control grounded in natural scenario imagery. We delved into how guided imagery sessions (GI) could modify weight perception and estimation across two experiments. Our objective was to evaluate the effectiveness of imagery, and especially GI, in replicating microgravity-induced alterations in weight perception.
Methods. A cohort of 64 undergraduates was segmented into two groups for participation in dual experiments, randomly allocated to either a space environment-focused GI (SS) or a nature-based scenario GI (NS). Study 1 assessed the effects of the GI on cognitive weight estimation of everyday objects, whereas Study 2 assessed the influence of imagery session on the weight and mass estimation of tangible objects with identical volume but different mass.
Results. In Study 1, the guided imagery session tailored to microgravity significantly impacted cognitive weight estimation of daily objects, evidenced by a main effect over time and an interaction effect exclusively within the space condition, where participants exhibited markedly lower average estimates at T2 relative to T1. On the contrary, in Study 2, SS condition participants rendered weight estimations - excluding mass estimations - significantly elevated compared to those in the NS condition.
Discussion. Imagery seems able to simulate microgravity-like effects when real objects are used, underscoring the profound influence of imagination on weight perception and estimation. These findings inaugurate novel avenues for applying mental imagery in sectors such as astronautics and rehabilitation, positing imagination as a potent instrument for enhancing adjustment to extreme environmental conditions and investigating microgravity's impact on terrestrial cognitive processes.

Survival value in spatial memory: a pilot study

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In the survival processing paradigm, participants are asked to rate the relevance of information in a survival scenario. The survival scenario consistently provides advantages compared to control scenarios, benefiting delayed recall and recognition. This has also been shown for object-location memory. Nairne et al. (2012) asked participants to imagine themselves stranded in the grasslands of a foreign land and to rate how difficult it would be to collect food items shown on a computer screen in different locations. Then, participants had to recall where they believed the food item had occurred. Participants exposed to the survival scenario showed better location memory. Costanzi et al. (2019) showed that emotions improve spatial memory performance when emotional and neutral stimuli compete for access to the working memory system using an object-relocation task with emotional and neutral pictures overlapping the objects to relocate. We aimed to explore whether the spatial memory advantage also occurs for incidentally learned survival stimuli. In this first experiment, we used the object relocation task developed by Costanzi et al. (2019), replacing emotional stimuli with pictures of food items as in Nairne et al. (2012). One hundred and sixty-nine college students executed an object-relocation task with food (survival) or everyday objects (non-survival) pictures or both (competition) overlapping the objects to relocate. Two hours later, they performed a forced-choice recognition test. We found no significant differences between groups in the recognition task. Unlike previous data on emotional stimuli, no advantage for survival items was found in the competition condition. However, we found that the performance at the object-relocation task was significantly better in the group tested with only survival stimuli than in the group tested with non-survival items. Results are discussed in terms of working memory processing of survival items.

Neurophysiological processes and well-being experience as response to space: some evidence from a neuroarchitecture approach

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The analysis of the relationships between space and neurophysiological correlates represents a growing field of interest in neuroarchitecture. At this regard the present study investigates the effect of four types of academic spaces (classroom, atrium, permanent exhibition space, and laboratory) on the electrophysiological (EEG) correlates and cognitive restoration of a sample of healthy students. By using a mixed model (qualitative-quantitative approach), neurophysiological data (Delta, Theta, Beta, and Gamma EEG frequency bands) were recorded through a wearable EEG system during space exploration by subjects. Subsequently, participants provided further mental representations and completed two psychometric scales (Building Wellbeing Scale and Perceived Restorativeness Scale). The main findings suggest that environments dedicated to permanent exhibitions and educational activities entail higher levels of coherence in spatial representation compared to laboratory settings. In addition, open spaces such as atriums have demonstrated greater social connectivity compared to traditional classrooms. About the neurophysiological responses, a significant higher response was found within the temporo-parietal regions as opposed to frontal regions for the Delta, Theta, and Gamma bands. Furthermore, an increase in Beta band activation in the left hemisphere compared to the right was observed, implying a possible involvement of positive emotions during exploration. The present results highlights the relevant application to architecture strategic planning, pointing out the significant contribution of brain-body-cognition relationship in designing spaces to promote the psychological and cognitive well-being.

Exploring Restorative Properties of Environments: A Comparison of Natural, Historical, Modern Urban Image Exposure

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Exposure to nature has been widely recognized to promote psychological and psychophysiological wellbeing in people. Restorative properties can characterize not only natural environments but also built environments, however, there is limited understanding of the positive effects of historical and artistic environments on emotions, cognitive functioning, and psychophysiological indexes. The current ongoing research is part of the iNEST (Interconnected Nord-Est Innovation Ecosystem – Spoke 4) project, with the aim of investigating the restorative potential of different types of environments.
Participants responded to questionnaires on their connection to nature and their preference for urban or natural environments. Then, they assessed their emotions and arousal before and after viewing AI-generated images showing i) natural, ii) historical, iii) historical with nature (mixed), iv) modern urban environments. Affective qualities and perceived restorativeness were measured after 4,30 minutes of image exposure in a Cave Automatic Virtual Environment. During the session, we measured psychophysiological indexes using Empatica E4 bracelet.
Preliminary results of 144 participants (81 women; age = 21.60, SD=2.28) showed a main effect of type of environment for total score of restorativeness ($F = 8.91$, $p < .001$, $\eta 2p = .112$), being-away ($F = 15.05$, $p < .001$, $\eta 2p = .17$), scope ($F = 8.65$, $p < .001$, $\eta 2p = .10$) with natural and mixed environments showing higher scores than historical ones. A main effect of the type of environment on relaxation ($F = 49.62$, $p < .001$, $\eta 2p = .41$) and pleasure ($F = 5.33$, $p = .006$, $\eta 2p = .07$) emerged with natural and mixed environments showing higher scores than historical ones. Post hoc analysis revealed that while historic environments exhibit fascination and coherence properties similar to natural environments, the latter are perceived as more restorative (total score and being away) and relaxing. This study improves our understanding of the interaction between individuals and their environments, highlighting the psychological processes that can promote restoration by comparing different types of environments.

How new verbal labels and inner speech contribute to the acquisition and execution of novel actions

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Language is a core human capacity that not only shares anatomical bases and cognitive processes with the sensorimotor system but can also modulate it. Specifically, recent studies showed that labels and inner speech impact perception and action. However, their impact on the acquisition and execution of novel actions has been neglected. Thus, we carried out a pilot study to investigate whether associating new verbal labels with novel actions facilitates action learning and execution; interfering with inner speech impacts participants' ability to acquire novel actions. We, thus, divided 40 participants into four groups, and asked them to perform a motor task. For all groups, the task consisted of observing, learning, and executing two actions. Both actions were composed of three motor chunks and differed in terms of motor chunks order. While participants of the control group observed, learned, and executed the actions, participants of group 2 received labels (monosyllabic non-words) to associate with actions. Instead, participants of groups 3 and 4 performed an articulatory suppression task (continuously repeating a syllable) either during action learning or while receiving action-label associations. Our results show that labels (group 2) significantly facilitate action learning (accuracy results) compared to all other groups and facilitate action execution (RTs and Action Execution Time) compared to the control group. However, interfering with inner speech through an articulatory suppression task does not impact participants' ability to acquire novel actions. At the same time, ratings about inner speech use show that the control group needs to use inner speech more than the other groups in order to drive their sensorimotor learning. After preregistering the study, we will test our hypotheses through two behavioral experiments in which kinematics parameters and mental strategies (e.g. visual imagery, verbal internalization etc.) will be measured as well.

The city changes as we change place: How position influences mental representation

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When recalling nearby occluded but familiar locations, people tend to display an egocentric bias. Therefore, recall is more likely to be in the orientation the target location is relative to the observer. Further, depending on the situation, the most practical mental representational format may vary. While a detailed egocentric representation may be favored near a target location, a more general allocentric representation may be more advantageous with greater distance.
In our study we aimed to find the position dependent recall effect, which has been found in real life experiments, in a virtual environment. We further tested whether the position dependent recall effect would weaken with distance to the target location.
For our experiment we used two prominent locations within the German city of Tübingen as target locations. All participants had lived at least one year in the city and confirmed being familiar with both target locations. We used six testing locations with varying distances from each target location, three east and three west of the respective target. In each trial participants started some meters from the testing location and moved towards it, the moving direction always also being in the direction of the respective target location. At the testing location participants were asked to recreate the respective target location using blocks representing structures found there. Participants were free in their block placement and were not aware of us assessing the recreations´ orientation. Each participant completed six trials with three trials for each target condition.
Participants displayed a position dependent recall effect in the orientation of their recreations. Further, there was a tendency for the position dependent recall effect to decline with increasing distance to the target location.

Survey knowledge after navigation: Is there an interplay between visuospatial working memory and spatial recall modality?

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Navigating environments is a fundamental ability of daily life, with survey knowledge playing a crucial role. Individuals vary in their ability in this type of knowledge. Research has shown that individual differences in visuospatial working memory (VSWM) ability can be related to differences in survey knowledge. However, other factors, such as the modalities of recall (cued vs. free recall) of survey knowledge, could interact with VSWM resources. The present study aims to clarify whether various types of VSWM contribute to survey knowledge under specific recall modalities or regardless of how spatial information is retrieved.
A sample of 74 young adults performed VSWM tasks with varying processing demands and degrees of active involvement. Then, participants actively learned a path by following an avatar with a joystick within a virtual city environment projected in a Cave Automatic Virtual Environment (CAVE). Following this, their survey knowledge was evaluated using a sketch map task conducted in two modalities: free recall and cued recall of landmark positions (within-participants design).
Concerning the results, the modality of recall was related with performance, with cued recall showing an advantage in sketch map accuracy over free recall. Only the VSWM task requiring simultaneous processing of information and active mental imagery was associated with sketch map accuracy, while sequential VSWM tasks or lower active VSWM tasks were not. Importantly, no interaction was found between VSWM tasks and the modality of recall (free vs. cued). Therefore, survey knowledge primarily relates to VSWM, regardless of recall modality.
In conclusion, our results suggest that the variability observed in survey knowledge after actively navigating an environment is associated with the simultaneous active processing of VSWM, with no interplay with the modalities of recall. In other words, regardless of the modality used to recall survey knowledge, VSWM abilities play a primary role for survey knowledge.

Spatial representation of a described path: can biophilic landmarks and emotions make the difference?

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The current study, conjugating evidence from environmental psychology and spatial cognition, approached route learning accuracy and related factors. Environment psychology shows that nature-based elements can improve wellbeing. Biophilic elements (natural or made with natural material) are indeed related to pleasantness and cognitive benefits. Spatial cognition studies have recently shown that positive emotionally-laden landmarks (compared to negative and neutral) are positively associated with environment representation accuracy after path learning. This evidence offers an opportunity to examine whether nature-based landmarks (with biophilic characteristics) are positive-laden and, thus, related to route learning accuracy. The aim of the study is to examine whether types of landmark (nature vs. artificial) and emotions impact the environment representation derived by path learning (reproduced with route description).
A sample of 163 participants (19-36 years; 97 women) listened to three route descriptions (with nature- vs. artificial- vs. function-based – control- landmarks). After listening to each description participants self-evaluated emotional (positive and negative) state, then performed the map drawing task and rated the type of strategies used. Wayfinding, nature-based inclinations and trait affect were also assessed. The results of regression models on map drawing accuracy showed that artificial-based description (compared to control one) and negative emotions negatively relate to the map accuracy; while positive emotions and map-based strategy increase the map accuracy. Wayfinding, nature-based inclinations and trait affect do not improve the model. Overall, these results confirmed the functional role of positive emotions and, on the contrary, the negative role of negative emotions on path learning accuracy (newly extended using route description). The artificial elements have a slightly negative impact on environment representation accuracy, even biophilic (nature-based elements) do not directly impact it. These findings offer insights on the role of type of landmarks features and emotions on path learning accuracy using descriptions and merits to be further investigated.

Does voluntary auditory spatial attention exist in depth plane?

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We hear our surroundings in everyday life. From the surroundings where various sounds are, we voluntarily control selective attention to sounds, that is endogenous auditory spatial attention, to achieve our current goals. Many researchers have reported nature of endogenous auditory spatial attention in a horizontal plane, however, there is little research focusing on a depth plane in endogenous auditory spatial attention. The present study conducted auditory attention task that involved speeded discrimination task to explore the auditory spatial attention in the depth plain. Three loudspeakers were located in different distances of 0.3 m, 1.3 m, and 2.3 m in front of participants. Most of sounds were presented from one loudspeaker and occasionally shifted to other locations. Twenty-one blindfolded participants discriminated the sounds as quickly and accurately as possible. The participants responded the fastest to the location that most of sounds were presented regardless of their location. In addition, the response became slower when the shifted distance was longer. Intriguingly, this progressive change in response with shifted distance also could be shown when the loudness at the ear position was similar for all loudspeakers. This result indicates that the participants can allocate their endogenous auditory spatial attention in the depth plane.

Proximity in VR: Examining the impact of teleportation on interpersonal space in social interactions with embodied agents.

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For decades, scientists from different interdisciplinary fields have sought to understand how people mediate personal space. Personal space is a key component of human interaction, as humans regulate personal space boundaries around their bodies in order to maintain a safe distance between themselves and elements of an environment. Emerging technologies like virtual reality (VR) present a novel and controlled medium via which the mediation of personal space can be readily measured. However, there are different technical elements of VR that may affect the mediation of personal space in these environments.

One such element is the locomotion technique deployed. VR applications often deploy nonnaturalistic locomotion techniques such as teleportation, which can rob users of cues that are important to spatial perception when navigating about an environment. The lack of motion cues provided to the user makes it challenging for individuals to accurately estimate the total distance travelled. These challenges in distance estimation will affect proximity, reliant on the user's perception of virtual space.

Another challenge posed by teleportation is accuracy in positioning oneself, a factor susceptible to user skill and experience. The difficulty in achieving the desired proximity to others may induce discomfort. The effort of repositioning oneself means users may unwillingly engage with others at unnatural distances.

This poster shares initial insights from a study observing how teleportation may affect the mediation of personal space in a VR environment. The user study explores interpersonal distance in interactions with AI agents, comparing teleportation against natural walking. The study uses embodied agents to enhance the precision of interpersonal space measurements for social interactions, providing valuable insights for understanding the psychological nuances of virtual experiences.

Deafness affects interpersonal distance preferences

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Interpersonal distance plays a critical role in communication and social interactions. Here we investigated for the first time whether deafness affects interpersonal distance preferences. Specifically, we asked deaf signers and hearing participants to report their preferred social distance from an approaching confederate using a standardized stop-distance paradigm, in which contexts' characteristics also varied. Results show that deaf participants prefer larger interpersonal distance than hearing individuals, regardless of the manipulation of context's characteristics. This difference may relate to different factors such as the use of sign language or a perceived self-vulnerability resulting into the need to put a larger distance between themselves and strangers. Our results may guide the development of inclusive guidelines for the space organization of everyday social contexts to guarantee comfortable spatial and social conditions for all individuals, regardless of their hearing status.

Unlocking cognitive maps through the eyes: evidence from eye-tracking and distributional semantics.

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Recent theoretical views suggest that conceptual knowledge may be organised into cognitive maps, taking the form of bidimensional representations (Bottini & Doeller, 2020). Interestingly, eye movements can be taken as a window into how people navigate these representations, shedding in turn light on the structural organization of cognitive maps. This is substantiated by studies showing that, during a random number generation task, spontaneous eye movements reflect the navigation of a number line, with larger shifts associated with the generation of more distant numbers (Loetscher, 2020; Bottini, 2023). However, the cognitive mechanisms supporting the formation of these maps remain still unknown. That is, it is not clear whether their structure is derived from direct sensory experience or whether it can be inferred from language experience (Gatti, Marelli, Vecchi & Rinaldi, 2022). Here, we combined eye-tracking with distributional semantics, as a computational tool to quantify language experience. We recorded eye movements while participants were asked to randomly generate a series of numbers (Experiment 1) and to recall a list of Italian cities (Experiment 2). We then predicted whether participants' eye movements were better explained by their physical (i.e., numerical distance or geographical distance) or linguistic distance (i.e., as extracted from fastText; Bojanowski et al., 2016). Combining these different methodologies, this study aims to probe whether spontaneous eye movements reflect the structural organization of conceptual knowledge and whether such an organization is induced from language experience.

Climate change and the spatial representation of the environment

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The Intergovernmental Panel on Climate Change (IPCC, 2007) reports that warming of the climate system is "unequivocal." The increase in temperatures would be 1.5 °C above pre-industrial levels (Sixth Assessment Round, IPCC, 2023). This could lead to the drying up of large portions of land with negative impacts on all living things, as also shown by the increase in individual anxiety about climate change. The situated spatial cognition perspective argues that spatial representations emerge from the interaction between environmental characteristics and the body-state. Thus, it is possible that the spatial representation of the environment is influenced by the consequences of climate change. To address this issue, virtual reality scenarios were created that simulated a naturalistic environment in two versions: verdant or arid. Each environment contained either a 36-metre or 46-metre path, for a total of four scenarios. Using Immersive Virtual Reality and an omni-directional VR treadmill, participants walked in these paths. After each path, participants judged both the metric (how long was the route in metres?) and the temporal (how long did it take to travel the route in seconds?) length of the path. The results showed that participants accurately discriminated between short and long paths. However, the same path was judged to be longer in metres in the arid scenario than in the verdant scenario. In contrast, there was no significant effect on time estimates. These results suggest that an environment made arid by climate change distorts the perception of path length and may consequently affect our spatial representation of the environment.

A preliminary study on the effectiveness of immersive virtual reality application for industrial training

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Customized Virtual Reality (VR) training programs have become very popular in industry in recent years. These programs may simulate most of the complex industrial procedures and enable repeated practice, safe exploration of potentially dangerous situations, and return quick feedbacks. Due to the growing usage of VR applications in a variety of fields where the learning process may be influenced by the multisensory simulation of real aspects, it is necessary to investigate if and how simulated sensory signals may affect the program's training efficacy. Here we focused on video and/or audio guidance on the learning of work procedures. Four different training methodologies were simulated: i) Traditional training, representative of an existing engine factory requiring motor assembly where all instructions were shown step by step through a monitor; ii) Audio training, based on audio instructions in addition to slides of traditional training; iii) video training, where the procedure was shown on the monitor and by 3D video animations; and iv) audio-video training, where the procedure was shown on the monitor and by the combination of audio instructions and video animations. As a control condition, a group of participants expert in the engine assembly procedure was included. The test was divided into three phases: assessment of cognitive skills (inclusion criteria); performance of the task in IVR, and questionnaires assessing individual attitudes toward new technologies and the experience in IVR. The experiment involved 32 subjects randomly assigned to the four experimental conditions. The preliminary results showed that the traditional training was less effective then single and combined audio-visual IVR procedures, and that audio instructions were particularly effective. Moreover, a higher sense of presence predicted higher effectiveness of the IVR training.

Title Effects of anticipating regret on pro-environmental behavior

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Psychological research has focused on developing a deeper theoretical and practical understanding of the best intervention strategies to support eco-friendly behaviours, attitudes, and practices. It has been noted that the anticipation of regret is a strong inducement to act. This is because, when options are being evaluated, the anticipated regret influences decision-makers to select those that will cause them the least amount of regret by using counterfactual reasoning. The overall goal is to encourage young individuals to make eco-friendly decisions by manipulating their regrets. For ten days, one EkoTok (short video) will be sent every day via an automated instant messaging chat. One-hundred-twenty-eight participants were recruited for the research. Following baseline measurements of environmental behaviour (total and subdimensions), individuals were split into two groups. The experimental group (GS) received EkoToks characterized by the manipulation of regret anticipations. The control group (GC) received only informative movies. Environmental behaviour measurements were gathered once more at the post-test and follow-up, which took place three months later. The interaction between the means of the two groups during the three measurement times was seen on: Total score ($F= 25.9$; $p<0.01$), Prosocial Behaviour ($F= 8.7$; $p<0.01$), Waste ($F= 9.9$; $p<0.01$), Reuse ($F= 30.8$; $p<0.01$), Recycling ($F= 15.9$; $p<0.01$), and Activism ($F= 29.6$; $p<0.01$). At the post-test, GS has higher scores than GC on the Total score ($F= 4.7$; $p<0.05$), Prosocial Behaviour ($F= 4.1$; $p<0.05$), Consumption ($F= 8.8$; $p<0.01$) and Recycling ($F= 11.5$; $p<0.01$). Comparing the outcomes between post - test and follow-up, GS presents higher scores than GC on Total score ($F= 22.6$; $p<0.01$), Prosocial Behaviour ($F= 4.2$; $p<0.01$), Consumption ($F= 9.5$; $p<0.01$), Reuse ($F= 5.4$; $p<0.01$), Recycling ($F= 20.5$; $p<0.01$) and Activism ($F= 29$; $p<0.01$).The study's findings provide the scientific foundation for an intervention aimed to encourage pro-environmental behaviour.

Effect of spectrum noise on selective attention

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Environmental noise represents a pressing contemporary issue for the worldwide population with notable implications on learning, working performance and well-being. Although numerous studies have associated noise with disruptors of cognitive performance, conflicting findings still exist within the literature. Previous investigations on broadband noise have highlighted the potential cognitive benefits of white noise (a type of noise with equal energy across all frequencies) particularly for attentive and working memory performances, while the effects of pink noise (a type of noise with equal energy per octave) were contradictory. Also modulated sound resulted to enhance the sustained attention, with best performances at 16 Hz. However, the impact of stimuli producing high fluctuating and roughness sensations is relatively unexplored. The study aimed to assess the effect of spectrum noise on cognitive executive functions. Participants performed modified attentional matrices with symbols, backward counting, forward and backward Corsi block-tapping test hearing different noises (i.e. white, pink, sharp, fluctuating, rough noise), and a quiet control condition. Also, participants were to rate the perceived level of aggravation of each noise and its potential effect on performance at the end of the experiment. Results reveal that white and sharp noise enhances attentional abilities significantly compared to quiet environments, while fluctuation and roughness noises did not.

Influence of the affective value of landmarks and imagined events on spatial memory.

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The influence of emotions on spatial memory has been the object of growing interest in recent years. Studies have shown that emotional visual stimuli serving as landmarks can improve navigation and spatial memory (Balaban et al., 2017; Piccardi et al., 2020; Ruotolo et al., 2019, 2020, 2021; Redhead et al., 2023). However, it is still unclear whether these effects are due to the emotions triggered by the stimulus used as landmark in itself or to the emotional value attributed to that landmark by the navigator. The purpose of the present study was to assess if the impact of the affective value of available information about the landmarks on spatial memory differed from the impact of the affective values of events experienced at their location. To this end, we asked 310 participants to watch a movie of a walk in an urban virtual environment containing twelve landmarks associated with a text description. Depending on the experimental condition, the descriptions contained either information about a personal event happening at the landmark location or information about the landmark itself. Information could be either emotionally positive or neutral. Several spatial tasks were used to assess participants spatial memory. Participants were asked to recall the landmarks encountered, recall the directions taken during the route and finally positioning the landmarks on a map. Results showed that participants exposed to descriptions containing information about the landmarks encountered were better to recall them than participants exposed to descriptions of personal events. No effect of the valence (positive vs. neutral) and type of description (Landmark related vs. Event) were observed on the other spatial tasks. However, analysis of participants' self-reported emotions towards the descriptions suggests that high arousing landmarks and events might impair landmarks and directions recall as well as the accuracy of their positioning on a map.

Can motor imagery training contribute to the acquisition of new words?

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Recent data shows that motor imagery training improves lexical-semantic access, supporting the idea that there is a close relationship between language and the motor system. This idea has been reinforced by studies showing that enriching the word learning process with gesture during learning improve word retention and retrieval. Based on these observations, we hypothesised that training in motor imagery could help in the learning of new words. After a lexical decision task, participants in the motor and kinaesthetic imagery (MKI) group had to imagine performing a grasping movement repeatedly for around ten minutes, while those in the visuo-spatial control (CVS) group had to count, add up and report the number of red dots seen among distractors. Participants were then asked to learn pseudowords that represented an objector an abstract word. Finally, they completed a new lexical decision task and performed two translation tasks: a Yes/No task (they had to indicate whether they knew or not the definition of the pseudoword) and a forced choice task (they had to recognise the definition of the word from 4 options). Preliminary data shows that MKI mainly helps with translation tasks and words relating to an object than related with an abstract word. These results may support the idea that verbal semantic and memory access are based on sensorimotor mental simulations.

The Influence of Emotional Stimuli Presented in Peripersonal and Extrapersonal Space on Egocentric and Allocentric Spatial Representations

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The location of objects in space can be represented either with respect to the body (egocentric frame) or with respect to an external element (allocentric frame). Furthermore, objects can be either near (within arm-reaching, peripersonal space) or far (far from reaching, extrapersonal space) from the body. Egocentric rather than allocentric spatial encoding is favoured in action-oriented tasks especially in peripersonal space (Ruggiero et al., 2021). Besides, the defensive function of peripersonal space allows people to react readily to negative events that occur near than far from the body (de Vignement & Ianneti, 2015). Instead, according to Fredrickson and Branigan (2005) positive emotions broaden individuals' attentional focus by making relationships between elements more salient at a global rather than local level. This suggests that emotions might influence the relationship between reference systems and space near and far from the body. However, no study has yet addressed this issue.
To fill this gap, thirty-six participants were asked to memorise triads of 3D geometric objects presented immediately after an emotional image (positive, negative, or neutral), either in peripersonal or extrapersonal space. Afterwards, they judged whether the target object was the one closest to them (egocentric task) or to another object (allocentric task). Based on the above, it is possible that negative events may favour egocentric over allocentric encoding in the peripersonal than extrapersonal space. Moreover, positive events might favour allocentric over egocentric encoding in the extrapersonal than peripersonal space.
In line with our hypothesis, in the positive condition allocentric judgements were more accurate in extrapersonal than in peripersonal space and more accurate than judgments in the neutral condition. However, the results did not reveal a facilitation for egocentric judgments in the peripersonal space in the negative condition. These results support the link between allocentric representations and extrapersonal space evidenced mainly through positive emotions.

Assessing object vs. spatial imagery through childhood play

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Our research investigates the development of individual differences in visual object imagery (processing pictorial appearance of objects in terms of their shape, color etc.) and spatial imagery (processing of spatial relations, and spatial transformations) abilities. As imagery assessment at preschool age is quite challenging, one promising direction is looking at play. Using factor analyses, we found that visual-object play (e.g., exploring drawing media or decorative crafts) can be dissociated from visual-spatial play (e.g., assembling and disassembling mechanisms or playing with construction toys), consistent with object and spatial visual imagery dimensions.

Our current research develops a comprehensive assessment of visual play that would be linked with object and spatial visualization abilities. We have created stimuli that are depictive and self-explanatory, so that children can understand how to play a game without a former knowledge, and a verbal description. These stimuli represent object (requiring processing of color, shape, pictorial details) and spatial (requiring processing of 3D structure, spatial relationships) visual manipulative play activities. Each picture represents the toy pieces, the hands performing an action such as assembling these pieces, and options of a creative product. The stimuli were administered for evaluation on different Likert scales in terms of their complexity, visual attractiveness, sex-appropriateness, usefulness, and educative purpose. We explored these stimuli evaluations in relation to cognitive and socio-economic profiles of participants.

We further aim to use these assessments of different visual play dimensions in the subsequent steps of our research investigating the adults' attitudes towards different forms of visual play as well as children's visual preferences and skills.

How we represent the interaction between interpersonal distance and mutual gaze in spatial memory

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In the spatial domain, egocentric (subject-to-object) and allocentric (object-to-object) reference frames are based on spatial coordinates; in the organization of social information, reference frames appear to be based on social coordinates: egocentric affiliative, allocentric social network (e.g., Peer et al., 2021; Tavares et al., 2015). Moreover, socio-cognitive factors can implicitly affect how we represent associated spatial information (Maddox et al., 2008). For example, proxemics studies have shown that individuals unconsciously modulate the interpersonal distance (intimate: 45cm; personal: 75; social: 150cm) and gaze (mutual or not) between themselves and others. Do these factors implicitly affect how we represent spatial information, i.e. according to egocentric and allocentric reference frames? To this end, participants were asked to memorize triads of geometric stimuli (e.g., sphere, cube, etc.). Behind each object, there was a pair of social (i.e., virtual humans with mutual/non-mutual gaze) or non-social (i.e., lamps or chairs, as control conditions) stimuli that could appear at intimate, personal, or social interpersonal distances from each other. We hypothesised that clear interpersonal relationships should elicit an egocentric versus allocentric advantage. Conversely, the social condition with unclear interpersonal relationships should induce a similar use of both frames of reference. The results revealed that intimate and social distances elicited an egocentric over allocentric advantage only in non-mutual, but no difference appeared in the combination of personal distance with mutual/non-mutual gaze. This pattern of results suggests that socio-cognitive information may implicitly affect spatial representations. Future research should investigate how social dynamics, which are automatically activated in a real-world context, can affect our spatial memory.

Spatial Information Processing of Functionally and Thematically Related Objects: an fNIRS Study

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The position of objects in the environment can be represented in coordinate (i.e. metric) and/or categorical (i.e. abstract, e.g. right/left) terms, using an egocentric (i.e. body-object relation) and/or allocentric (i.e. object-object relation) reference frame. It has been shown that egocentric representations are supported by a fronto-parietal brain network, more right-sided for coordinate relations, whereas allocentric representations are supported by a bilateral occipito-temporal network, along with inferior parietal areas for coordinate relations. Previous studies have mainly used abstract stimuli (e.g. lines or geometric shapes), whereas in everyday life we encode the position of objects whose function (e.g. a fork is used for eating) and thematic relationship (e.g. objects used with others, such as a fork and a plate) we know. Both functional and thematic semantic knowledge is supported by temporal brain areas.
The aim and novelty of this study is to verify whether the cortical correlates of spatial representations are modulated by the type of semantic relationship between objects. Twenty-two participants were shown with triads of functionally (e.g., hourglass-chronometer-watch) or thematically (e.g., fork-napkin-plate) related objects and they were asked to judge if a target object was: (i) closest/farthest to them (egocentric-coordinate); (ii) on their right/left (egocentric-categorical); (iii) closest/farthest to object Y (allocentric-coordinate); (iv) on the right/left of object Y (allocentric-categorical). Cortical haemodynamic activity related to each spatial judgement was recorded by functional near-infrared spectroscopy (fNIRS) in a block design.
The results showed that during allocentric coordinate judgments, temporal areas were more active for thematically rather than functionally related objects, whereas parietal areas were more involved for functionally related objects. Furthermore, an increased activation in both parietal and temporal areas was observed during egocentric coordinate judgments with thematically related objects. These results suggest that semantic relations between objects can modulate the neural correlates of spatial representations, especially of allocentric and coordinate ones.

Egocentric and allocentric spatial representations in different indoor environments: the influence of comfortable vs basic rooms

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While research in environmental psychology has explored the effect of life contexts on well-being and psychological restoration, little is known about how such contexts may influence spatial memory. Here we focused on the possible effect of different interior features on the egocentric (body-based) and allocentric (environment-based) representations. Specifically, we compared the capacity to provide egocentric and allocentric spatial judgments within three types of rooms: Comfort room (comfortable soft-touch coverings and shades of blue and green colors); Modern room (high-quality coverings and predominance of white); Basic room (basic coverings and white/brownish colors). Moreover, since design and architecture are linked to individuals' emotions and well-being, we also tested for the possible implication of a more positive/negative environment-induced mood on spatial judgments. To this end, participants rated, on a 9-point Likert scale, the extent to which each room induced calmness, energy, happiness, nervousness, tiredness, and sadness (1 = not at all; 9 = very much).
Results suggest that Comfort and Modern rooms foster more accurate spatial judgments than the Basic room. A negative mood affects subjects' spatial performance: the more nervous or sad the rooms made the participants, the less accurate and fast the spatial judgments were.
These preliminary results indicate that environmental contexts, together with the emotions they raise, may play an important role on human spatial memory capacity.

Eye-tracking technology to understand anatomy learning strategy

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Eye-tracking data enables the analysis of eye behavior in various contexts (surgery or sports). Fixations, gaze points and pupillometric information offer valuable insights into visual attention, orientation strategies, and cognitive load (Zheng et al., 2015). Additionally, eye tracking technology has the capability to identify complex anatomical structures (Hellum et al., 2022). And numerous studies have utilized expert gaze fixation strategies to offer guidance to novices (Ji et al., 2022 ; Leff et al., 2015). Our study was conducted within the context of anatomy learning. Its objective is to compare the visual strategies used by novices and experts in anatomy during a task of recognizing anatomical bone segments.
Two groups of students participated in this study based on their anatomy level : novices (1st year kinesiology students, n=50) and experts (4th year osteopathy students, n=17) according to a pretest-test protocol. The pretest allows to evaluate the participants' cognitive and visuo-spatial abilities (MRT, Rey figure, etc.). The test consists of two tasks : 1) recognition of human body' bones (humerus, tibia, femur), 2) determination of the bones' laterality (left, right). Specific test data are obtained : time and accuracy of responses, as well as eye-tracking data : fixations and saccades. The gaze points indicate the order and number of fixations on the bone ; the size of each cercle (i.e. fixation) is proportional to the time spent on it. Experts seem to have fewer and shorter fixations than novices. Data are still under analysis and may show more precise comparisons on the tests between experts and novices and correlations with the pretest data.
The difficulties encountered by novices when learning anatomy can be addressed by implementing a guidance system based on the strategies used by the experts. Eye-tracking technology can be easily transferable to other disciplines and facilitate learning for all.

Visualizing the Invisible: Visual Imagery Shapes Pseudo-Hallucinatory Experiences

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Visual mental imagery, the ability to "see" with the mind's eye, varies greatly across individuals, from vivid imagery to aphantasia (the absence of visual imagery). It is currently unknown to what extent natural imagery ability interacts with perception of the external environment. Previous research suggests vivid imagery may enhance divergent perceptual experiences like hallucinations, but hallucinations are difficult to investigate. The Ganzflicker paradigm makes use of flickering light to induce pseudo-hallucinations reliably across the healthy population, and offers a unique window into the relationship between imagery and perception. Importantly, individuals with vivid imagery report more frequent and complex pseudo-hallucinations than individuals with aphantasia.

Here, we analyzed written descriptions of pseudo-hallucinations from 4365 participants using the Lancaster Sensorimotor (LS) Norms—a database quantifying words' sensory and motor dimensions—and the vision-language model DALL·E.

We found a strong correlation between the vividness of visual imagery and the perceptual richness of hallucinatory descriptions; individuals with stronger visual imagery reported more complex and life-like hallucinations. We further examined the thematic essence of experiences, assessing the types of words used in the descriptions using five imageable motor dimensions (head, foot, mouth, hand, torso) and an interoceptive (non-imageable) dimension from the LS Norms. Descriptions rich in mouth and hand references significantly predicted higher visual imagery scores, suggesting realistic content in the hallucinations of strong visual imagers. In contrast, hallucination descriptions of weak imagers were richer in interoceptive language, describing non-imageable concepts, like feelings.

Finally, we used DALL·E to visualize hallucinations described by participants with varying visual imagery vividness. Descriptions from strong imagers translated into images of real-life objects, while those from weak imagers predominantly resulted in abstract geometric shapes. These results validate the relationship between visual imagery vividness and the perception of induced hallucinations, and further offer insights into the features of these subjective experiences.

Complex Visual Experiences are Evoked by Temporal not Occipital Intracerebral Stimulation

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Visual mental imagery, the ability to represent visual objects or scenes without direct sensory input, resembles actual perceptual experiences. The predominant model considers visual mental imagery as reverse visual perception, with brain activity originating in prefrontal regions and extending to the primary visual cortex. However, patients with cortical blindness can exhibit normal visual mental imagery, contrary to the model's prediction. Another way to assess the model is to observe the effects of in vivo electrical stimulation mapping (ESM) in patients with drug-resistant epilepsy and implanted intracerebral electrodes for stereotactic EEG recording.

Here we analyzed the experiential manifestations induced by ESM in 3 epileptic patients with implanted intracerebral electrodes targeting the temporal and occipital lobes.

The results showed that occipital stimulation only triggered simple visual manifestations such as flashes, flickering, or elemental geometric shapes. On the other hand, temporal stimulation led to the emergence of complex visual imagery, such as a "squared picture full of many white flowers." These findings are incompatible with the dominant model of visual mental imagery. They instead support an alternative model that emphasizes the integrated functioning of high-level visual areas in the ventral temporal cortex with frontoparietal networks.

Simulating Brain Chaos Through Electrical Circuit Emulation: An Approach

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In this study, we propose an innovative approach to emulate brain chaos using electrical circuits, wherein we integrate the Chua circuit and diode tunneling, along with additional circuit components, to explore new manifestations of cerebral chaos. By combining these elements, we aim to capture the intricate dynamics observed in brain activity more comprehensively. The Chua circuit provides a foundation for chaotic behavior, while incorporating diode tunneling and other circuit elements introduces further complexity, potentially mimicking various aspects of neuronal firing patterns and network interactions. Through extensive numerical simulations and analysis, we investigate the emergent chaotic phenomena and characterize the novel dynamics arising from the expanded circuit architecture. Our research contributes to the advancement of understanding brain dynamics and opens avenues for exploring diverse manifestations of chaos in neural systems.

Using drawing tasks to probe visuospatial memory in disorders of perception and action

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Drawing tasks are a fundamental component of neuropsychological assessment, although they tend to be analysed qualitatively and their administration can be open to bias. In this talk I will discuss the development of quantitative metrics of drawing and show how they can reveal more nuanced accounts of processes underlying perception and action. Neuropsychological evidence suggests that visuospatial memory is subserved by two separable processing systems, with dorsal underpinnings for global form and ventral underpinnings for the integration of part elements. I will present data from ventral stream and a dorsal stream patients completing tasks that explored the effects of Gestalt organisation upon copy and recollection of hierarchical stimuli. I will also present new drawing-from-memory data in healthy younger adults, which have ramifications for a ubiquitous form of cognitive assessment. Finally, I will consider the controversial role that mental imagery occupies in attempts to model the cognitive processes underlying drawing production.

Exploring Object Visualization Abilities in Artistic Domains: : The Role of Color, Shape, and Texture Visualization

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Our study, guided by neuroscience evidence that identifies distinct neural areas for processing color, texture, and shape, aimed to explore the potential subdivision of object visualization ability into its sub-components. The performance of 498 students from the Rome University of Fine Arts, spanning 14 artistic specializations on color, texture, and shape visualization assessments, was analyzed. The results demonstrate distinct visual ability profiles among students of different artistic specializations. Cinema and Sculpture students demonstrated marked proficiency in visualizing the shape of the objects, whereas Visual and Innovation Design students performed the highest on texture visualization assessments. Computer Animation students excelled in color visualization. These distinctions validate the hypothesis that object visualization ability is comprised of specialized, discrete subcomponents, each of critical importance to specific artistic disciplines. The results demonstrate that recognizing these distinct object visualization abilities is crucial for developing tailored educational strategies in art schools.

The Contributions of Visual-Spatial Imagery to Learning Organic Chemistry

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In organic chemistry, spatial reasoning is critical for understanding 3D molecular structure and representing spatial information in diagrams. Our studies reveal that early in instruction, students' strategies are primarily based on imagery, but with instruction, they use more algorithmic strategies and abstract representations. An intervention study compared classes in which students were trained to use either mental imagery strategies, analytic strategies, or their combination in solving organic chemistry problems. Students adopted more analytic strategies after training, but those who trained in the combined use of mental imagery and analytic strategies performed best in posttests, and this condition eliminated a sex difference in achievement. Other studies showed students are sensitive to "chunks" prevalent in chemistry representations, and that manipulating concrete models can enhance understanding of the 3D molecular structure. Imagery is an important strategy in learning organic chemistry, but with instruction, is augmented by chunking and analytic strategies.

Decoding the contents and spatial topography of mental images in high-level visual cortex

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I will review a series of functional neuroimaging studies conducted in our laboratory over the last ten years focusing on the neural representations and connectivity within the high-level visual cortex during visuo-spatial imagery. Beyond the common dichotomy between object and spatial imagery, we showed that the activity in the high-level visual cortex depends both on the content and the spatial topography of the mental images, which are encoded in a highly distributed way. In particular, neural activity patterns in scene-responsive regions encode the identity, real-world position, and spatial distances between familiar landmarks, during both recognition and imagery and even across the two domains. The differences between recognition and imagery are best described in terms of differential effective connectivity (i.e., causal relationships) between the same brain regions. Finally, connectivity patterns are predictive of individual differences in mental imagery and navigational abilities.

Visual mental imagery and visual hallucinations

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Visual mental imagery and visual hallucinations are both visual experiences occurring in absence of a physical stimuli. This common phenomenological characteristic suggests that these processes may share, at last partially, neural basis underpinning the generation of visual images. However neural underpinnings of these two processes are still unknown and the relations between visual hallucinations and visual mental imagery has been poorly investigated.
In this talk a revision of the literature on the eventual relationship between these visual mental imagery and visual hallucinations across pathological contexts in which visual hallucinations occur will be presented. Furthermore, data from a work exploring visual imagery process in patients Lewy body dementia will be presented.

Teleporting impairs scene recognition in virtual environments

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The present study examined if movement by teleporting in virtual environments can affect the ability to recognize a spatial scene from a new viewpoint. In Experiment 1, participants carried out a scene recognition task in which they first studied a layout of objects on a circular table and then indicated if the scene had changed. During the delay period participants stayed at the encoding viewpoint or moved to a new standpoint around the table with either physical movement or teleporting. Results revealed that recognition performance was slower and less accurate with teleporting compared to physical and no movement. A second experiment, in which participants translated by teleporting but had to execute a physical rotation towards the table, replicated the results of Experiment 1. Overall, these findings show that scene recognition from a novel viewpoint is impaired when moving with teleporting. The implications of these findings for spatial cognition are discussed.

Perception of Virtual Characters in VR

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How does virtual reality impact human perception? What are virtual humans? What is “uncanny valley”? These are just some of the questions we will attempt to answer in this talk. Some basic concepts, such as immersion, presence, social presence and embodiment will be explained and recent research associated with them. Particular focus will be on the perception of virtual humans, how we use them and what improves or hinders our response to them in virtual reality. This talk will serve as an introduction to virtual characters which play a major role in the following presentations of this symposium.

Using VR to explore the role of social cues and interaction in second language learning

A. Zappa[1]

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Much of what we know about language learning results from paradigms that are a far cry from how languages are learned in real life. Importantly, a number of second language (L2) studies suggest that practicing an L2 in enriched physical and social contexts is particularly beneficial for reaching a high level of proficiency. Virtual reality (VR) offers a controlled, yet naturalistic environment to investigate how social contexts influence language learning. I will present research that uses VR to manipulate specific social cues - such as social gaze and social feedback - and examine how they might influence language learning using behavioural and eye-tracking measures.

Immersive technologies and non-verbal interactions during locomotion: validation, applications & future directions

A. Olivier[1]

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The ability to adapt our locomotion to our surrounding environment is crucial for safe mobility and social participation. Understanding those adaptations of daily locomotion has been initially performed in the laboratory using real-world settings. Recent advances in virtual reality (VR) allow participants to interact with objects and people in an environment where features can be fully manipulated and allow to represent real life contexts with a high level of experimental standardisation. This presentation aims at conveying the recent research that has been conducted to validate the use of VR to study human behaviour in populated environments, both at the trajectory and gaze levels. In addition, the presentation aims also at conveying new research paradigms that were impossible to design in real-life settings and the ways that some of this evidence has been used for clinical application. Finally, this presentation will discuss the ongoing challenges with immersive technologies and future directions.

Collecting “crowd” data with Virtual Reality

J. Pettre[1]

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The acquisition of crowd data is essential for modelling crowd behaviour, evaluating simulation results and calibrating models. However, existing data sets are still rare. The reason is simple and is directly linked to the complexity and cost of acquiring them. Virtual reality provides a solution to both these problems: it enables a single participant to be exposed to complex, controlled and repeatable situations. However, the use of virtual reality requires the ecological validity of the situations of interest to be verified. In this presentation, we will review our recent results in this direction and detail the ‘one-man-crowd’ technique that enables us to record high-quality collective movement data involving a single user.

Cognitive performance in immersive technology

I. van der Ham[1]

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Immersive technology such as virtual and augmented reality is evolving and provides a novel source of experiential learning, both in education and healthcare. In this contribution, I will discuss the crucial characteristics of immersive technology, and how we use them for optimal learning and cognitive performance. Based on a range of recent experimental findings, I will present a framework of successful learning through immersive technology. First of all, the level of immersiveness of the devices used contributes to the learning experience. It is not only the technology itself, but also characteristics of the user that determines the learning experience. Spatial skill level for instance is of importance, specifically when immersion is relatively low. Moreover, personal beliefs concerning cognitive performance (e.g. stereotypes and self-efficacy) can be addressed through avatar design to achieve optimal performance. Directions for further research and practical applications are discussed.

Temporal and spatial cognition in the wild: how technologies affect our representations?

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In this contribution, I will present some results obtained in a project dedicated to the study of temporal and spatial cognition in humans during real-world navigation. Wildtimes project explored how technologies and paradigms of the lab sustained the test of real-life experimentation in ecological settings. We also asked how transportation technologies affect our representation of time and space, and in turn, how our representation of time and space may affect the transport mode and itinerary we select. Some results will be presented to illustrate these issues and we'll discuss the limits and how much we can combine experimental control constraints and ecological validity.

Is GPS use associated with our navigation skills? A systematic review and meta-analysis

L. Miola[1], V. Muffato[1], E. Sella[1], C. Meneghetti[1], F. Pazzaglia[2]

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With the increasing accessibility of devices with Global Positioning System (GPS) there is growing interest in understanding their impact on people's navigation abilities. We conducted a systematic review and meta-analysis aiming to (i) summarize the evidence on GPS use and navigation ability, (ii) examine the methods and instruments used to measure the effects of GPS use, and (iii) assess the methodological quality (risk of bias) of studies. Out of 907 articles, 23 studies met the inclusion criteria revealing a negative association between GPS use and environmental knowledge (r =−0.18 [95%CI:−0.28,−0.08]) and a self-reported sense of direction (r =−0.25 [95%CI:−0.39, −0.12]) and a positive yet not significant association with wayfinding (r =0.07 [95%CI:−0.28,0.41]). The literature has methodological weaknesses that limit the quality of evidence, with 68% of the studies classified with a moderate to high risk of bias. Future studies should adopt standardized measurements and procedures to further confirm these results.

Human sense of orientation: Where does the use of mobile navigation tools lead us?

T. Ishikawa[1]

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Knowing where you are in the environment, or spatial orientation, is a fundamental everyday spatial behavior, but poses difficulty for some people, especially people with a poor sense of direction. There are maps and other spatial representations, and nowadays, particularly, advanced mobile navigation tools, available as navigation assistance, but finding one's way and orienting oneself in the surrounding environment with those tools are not as straightforward as many people may assume. Furthermore, in accordance with anecdotal reports of tragic, and somewhat unbelievable, navigation errors due to passive following of in-car navigation systems, empirical research has shown that an overreliance on mobile navigation tools has negative impacts, both short-term and long-term, on the user's spatial learning and behavior. In this talk, I will discuss existing research on human spatial cognition and consider the past, present, and future of human spatial awareness.

Exploring social touch perception in fibromyalgia and endometriosis: insights from virtual reality

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Fibromyalgia (FM) and endometriosis (EN) significantly affect the quality of life of women, particularly in social and intimate relationships where social touch plays a crucial role. To explore touch perception in FM and EN, we conducted two separate studies in Immersive Virtual Reality (IVR) in which women with FM and EN, along with healthy peers, received virtual touches on various body parts of an embodied avatar. FM participants provided assessments of touch appropriateness, pleasantness, and erogeneity, while EN women evaluated these aspects alongside perceived pain when touched. Interestingly, FM women reported overall higher ratings compared to the control group, suggesting a generalized heightened response to touch, while EN women rated touches in pelvic areas as painful. These findings underscore the importance of studying how FM and EN impact social touch perception in women. IVR emerges as a valuable tool for this investigation, offering potentially lower discomfort compared to real-life touches.

Effect of Psycopathy on the perception of Interpersonal Distance

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This study investigates the impact of psychopathy on spatial perception in social settings. We examined how individuals with varying levels of psychopathy, measured using a self-report questionnaire, perceived physical space when interacting with an avatar displaying different facial expressions. The participants were instructed to stop the avatar at a designated distance. Our results show that while facial expressions had no effect on spatial judgments, psychopathy levels did influence these perceptions. Specifically, individuals with higher psychopathy scores allowed the avatar to approach closer than those with lower scores, who maintained a greater distance. This pattern changed when the avatar was replaced with a non-human object, highlighting that the influence of psychopathy on spatial perception is specific to social stimuli. These findings indicate that psychopathy may affect early visual processing stages, altering basic spatial perception in social contexts.

The effects of sexual objectification on own body attention, emotional response, and interpersonal interaction

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Female Sexual Objectification refers to perceiving and treating women based on their body appearance. Self-objectification occurs when women internalize this objectifying perspective. Across three studies, emotional and interpersonal consequences of sexual objectification are investigated from both the observer's objectifying gaze and the perspective of the objectified woman.
Study 1 shows that the behavioural and neural responses underlying observer's empathic reactions to physical pain are dampened when painful scenarios involve objectified women.
Study 2 and 3 show that the specific emotional response and the level of self-objectification in women exposed to objectifying interactions affect their behaviour in subsequent social interactions.
All together, these findings have implication in the relationship between sexual objectification and sexual violence, and between self-objectification, feeling ashamed and psychopathology associated with distorted body perception.

The effects of emotion imitation on personal space regulation

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In this study, we explored how adolescents regulate personal space (PS), in response to emotional cues, focusing on the impact of emotion imitation. We hypothesized that emotion imitation plays a pivotal role in PS regulation during adolescence, a period marked by developing emotion regulation abilities (Zeman et al., 2006). Participants underwent an emotional stop-distance task in a virtual reality (VR) setting (Ruggiero et al., 2017) before and after a session where facial emotional expressions were imitated (experimental group, N=30 adolescents) or observed (control group, N=30 adolescents). Results showed that participants maintained greater distances from the Angry, compared to Neutral and Happy Avatar. Moreover, the experimental group chose shorter distances with Happy Avatar and longer distances with Angry Avatar in the post-imitation session, whilst the control group showed no significant changes. These findings suggest that imitation of emotional expressions refines PS adjustments during adolescence, potentially aiding emotion regulation and social behavior.