MULTISENSORY STIMULATION AND AROUSAL

STIMOLAZIONE MULTISENSORIALE E AROUSAL

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Abstract

This literature research paper examines the activation of Arousal and studies its neurological processes in order to study protocols, in a controlled space, that can elicit emotional states that act on the subject's arousal to lead him to the best attentional performance.
The control of arousal through emotion should take place by modulating sensory stimuli, inside the multisensory room, realized in the Heracle Educational Neuroscience Laboratory, of the University Niccolò Cusano of Rome. The multisensory room offers a selection of primary stimuli in an attractive environment designed to develop cognitive skills through perception. Multisensory stimulation is, therefore, an approach aimed at stimulating the five senses in a controlled manner. Multisensory stimulation allows to reorganize the relationship with the external world and improves its comprehensibility and usability. Repeated and constant stimulation can exercise implicit learning (habit to a specific stimulus). The design hypothesis of the interventions is to modulate the stimuli according to the user's input arousal to obtain the best attentional state.

Questo lavoro di ricerca bibliografica esamina l'attivazione dell'Arousal e ne studia i processi neurologici al fine di studiare protocolli, in uno spazio controllato, in grado di suscitare stati emotivi che agiscono sull'eccitazione del soggetto per condurlo alla migliore performance attenzionale.
Il controllo dell'eccitazione attraverso l'emozione dovrebbe avvenire modulando gli stimoli sensoriali, all'interno della sala multisensoriale, realizzata nel Laboratorio di Neuroscienze Educative Heracle, dell'Università Niccolò Cusano di Roma. La sala multisensoriale offre una selezione di stimoli primari in un ambiente attraente progettato per sviluppare le capacità cognitive attraverso la percezione. La stimolazione multisensoriale è, quindi, un approccio volto a stimolare i cinque sensi in maniera controllata. La stimolazione multisensoriale permette di riorganizzare la relazione con il mondo esterno e migliora la sua comprensibilità e fruibilità. La stimolazione ripetuta e costante può esercitare l'apprendimento implicito (abitudine a uno stimolo specifico). L'ipotesi progettuale degli interventi è quella di modulare gli stimoli in base all'eccitazione dell'input dell'utente per ottenere il miglior stato attenzionale.

Keywords

Arousal, Attention, Stimuli Control, Children, Approach.
Eccitazione, Attenzione, Controllo degli Stimoli, Bambini, Approccio.

Introduction

This literature review examines the activation of arousal and studies its neurological processes in order to implement protocols, in a controlled space, that can elicit emotional states that act on the subject's arousal to lead him to the best attentional performance.

The control of arousal through emotion should take place by modulating sensory stimuli, inside the multisensory room, realised in the Heracle Educational Neuroscience Laboratory, at the University of Rome Niccolò Cusano. The multisensory room offers a selection of primary stimuli in an attractive environment designed to develop cognitive skills through perception. Multisensory stimulation is, therefore, an approach aimed at exciting or stimulating the five senses in a controlled way. Multisensory stimulation enables the reorganisation of the relationship with the external world and improves its comprehensibility and usability. The stimuli present in the multisensory room are visual (use of lights, bubble tube sensory, led torch, multi-media approach), vibroacoustic, sound and olfactory, tactile and kinaesthetic (Chitsey A. M., Haight B. K., Jones M. M., 2021). The tools used are domoticised and controlled remotely by the operator. An individual sensory pathway is designed and programmed for each user entering the room, with the aim of achieving the goals set for the subject by eliciting emotional experiences. The interventions can be multiple (cognitive enhancement, mnestic recovery, emotion management, relationship development, etc.) and the users heterogeneous. The administration, repeated and constant, of sensory impulses can exercise implicit learning (habit to a specific stimulus). The hypothesis of intervention design is to modulate the stimuli according to the user's input arousal. to obtain the best attentional state. According to this theory, in fact, if the subject, at observation, should have a level of hypo-arousal, the environment should respect the state, gradually integrating the stimuli. Vice versa, a particularly active subject will need a hyper-stimulating environment and will be led to the optimal level of attention by removing/modulating some excitations.

The basis of this model is based on the "Perceptual Symbol System", (Barsalou, 2003) which demonstrates the theory that the perceptual material collected by the sensory systems during the experience is not translated into amodal terms, but "captured" by the memory systems of higher order sensory areas. This allows the sensory characteristics of the external object to be reactivated later, through a process of "simulation", even if absent. This explains cognitive processes such as memorisation, language and reasoning, emphasising the sensorial component. Ellis and Tucker (2000) proposed the term "microaffordance" to emphasise continuity and discontinuity with the Gibsonian notion. Continuity focuses on the activation of the motor system through the observation of objects evoking a potential action towards the same (Gallese, 2008; Jeannerod, 2006). Discontinuity, on the other hand, lies in the focus on specific motor components activated by (micro) objects as well as the neural basis of (micro)affordances, understood as visuomotor associations welded with experience in the brain (Caruana, Borghi, 2013).

1 Arousal

The degree of activation or arousal refers to the intensity of physiological responses to an emotion. (Bisagno et all, 2019). It is a condition of the nervous system, characterised by a general state of arousal with increased attentional-cognitive state of vigilance and prompt reaction to particular stimuli, which require increased psychophysical performance (Ledoux, 2015). The situations that can determine a change in arousal are all those that subject the subject to psycho-physical stress or, in any case, to intense emotions, while the stimuli can be both internal (subjective) and external (environmental and social). During arousal, the subject has a level of vigilance that is temporarily higher than average, which allows him or her to rapidly analyse the situation he or she is experiencing and to react quickly to it.

During a period of arousal, the subject's central, peripheral and vegetative nervous systems are involved, leading to: a rise in blood pressure; tachycardia (increased heart rate); tachypnoea (increased respiratory rate); increased sweating; muscle contraction; increased production of neurotransmitters such as acetylcholine, adrenalin, noradrenalin, dopamine, cortisol and serotonin.

Physical expressions similar to those of an emotion can be produced independently of it or can relate to another emotional state: one can, for example, shiver from cold or fear, but also in a situation that requires great attention to the environment (Ledoux 2015).

As Osman and Kingoe (2019) show in their research, emotions involve higher cognitive (evaluative) processes, which organise the correct responses according to the situation the organism is in. And while the individual components may be biologically determined, emotion is charged with psychological significance. They are thus a set of experiences that are constructed and psychologically adapted to a particular situation.

During arousal, mainly the limbic system, frontal and temporal lobes, plus the endocrine pancreas are activated. The electroencephalogram is characterised by the strong presence of beta-type brain waves.

Visual and auditory stimuli processed by the sensory cortex and transformed into information are sent to the transitional region, where different sensory modalities can be combined. It is then in the transitional circuits that multisensory and all-encompassing representations of the world are formed. It is in this area of the brain that we leave the strictly perceptual sphere and 'enter' the conceptual one. Conceptual representations are sent from the transitional region to the hippocampus, which will make them even more complex (Ledoux, 2015). This leads to a general condition of increased sensory alertness, mobility and reflexes, and predisposes the body to rapid psychomotor responses and increased muscle strength.

Arousal influences memory capacity, attention, decision-making, neuromuscular activity, expression of emotions and behavioural patterns. The increase in neurovegetative activity linked to arousal makes it possible to pursue basic needs (hunger, thirst, sleep, sexual activity, etc.) and/or to cope with emergency situations in which the survival of the organism is at risk (dangerous situations).

2 Emotional experience

According to Ledoux's (2015) theory, conscious experiences could be related to working memory which treats consciousness in terms of process rather than content through computational functions (which could, therefore, be responsible for conscious experiences). Consciousness, in fact, is not a specific quality, or an 'on/off' condition, but a quantity, varying both in people and in time and depending on what it is referred to. According to Imbasciati (2017), in fact, it would be more correct to speak of a 'capacity' of consciousness. If a visual stimulus is encountered, the signal will be sent to the visual thalamus and here to the visual cortex, where an imaginative representation of the stimulus is created. Connections between the visual cortex and the cortical networks of long-term memory activate memories, which are linked to the image and related experiences. Connections between long-term and working memory allow memories to be integrated into working memory with the sensory representation of the stimulus, enabling it to become conscious, i.e., real. Moreover, the results of recent research by Dance, Ward and Simner (2021) show, for the first time, that sensory imagery and sensory sensitivity are linked. But this is not enough to make the experience 'emotional'. The direct implication of the amygdala on the cortex by sending cortical projections to different areas: prefrontal cortex (working memory and attention), sensory cortex, hippocampus is crucial. Thanks to these projections, the amygdala influences higher-order thought processes (Ledoux, 2015). According to the author, another fundamental element for emotional experience is the arousal triggered by the amygdala. With arousal, in fact, the cells of the cortex and the thalamic regions, which send most of the signals to it, become more sensitive. During arousal, most of the cortex is potentially hypersensitive, but it is the systems that process information that are most affected. A final element in emotional experience is body feedback. According to Damasio (1995), this is information that underlies the 'visceral' feelings of our experiences and decision-making processes. During emotional reactions, the body has multiple possibilities to retroact on the brain's processing of information and on our conscious feelings. Emotions and feedback, however, have different speeds: the former are dynamic and fickle (fear can turn into relief or anger), while the latter contribute to change over time.

3 Appraisal and observation

In the 1980s, the so-called 'appraisal theories' were born, a term that means 'evaluation': it designates the cognitive evaluation of stimuli. Different emotions are characterised by different appraisal systems, consisting of specific components or dimensions; appraisal, therefore, is at the origin of the emotional response. (Ledoux, 2002). Alongside cognitive appraisal, the importance of subjectivity in the perception of an emotional experience stands out. The main evaluations concern the pleasant or unpleasant character of the event followed by the emotion, its novelty, its duration, the uncertainty about its consequences, its compatibility with the reference social norms and with the individual's self-image (Dance, Ward and Simner, 2021).

For appraisal theory, emotions are adaptive phenomena, fulfilling self-regulatory functions. (1) Regulating attention: through appraisal the emotional system monitors the environment for significant events and alerts consciousness when it discovers them. It cannot depend on focused attention, but on unconscious, pre-attentive attention. The system is rapid, but not very informative. (2) Motivational: With associated physiological activities and action tendencies, the emotional response prepares the individual and motivates him/her to deal with the event that provoked the emotion. It requires a detailed description of the situational stimulus. The system can be neither pre-attentive nor unconscious.

There are two types of processing, based on the two different functions of the emotion, which can be linked to Le Douper (the thalamic and cortical pathways), of amygdala activation. The first is the Schematic (Smith) which derives from the thalamus and is exemplified by priming - facilitation - and the propagation of activation. It implies a pre-attentive activation of environmental monitoring. Fast and automatic processes that can activate many types of memory simultaneously. They operate outside of awareness and require few attentional resources. They do not depend totally on verbal information, but on any kind of information. The second is Conceptual: cortical and conscious processing of meaning and triggering of motivation to action. It is a flexible system, but slower. It works sequentially, involving many attentional resources (Novak, 2010).

The two types of processing interact with each other.

1) Sensory-motor: More primitive, it comprises innate expressive-motor programmes and activation brain systems that can be stimulated simultaneously by various factors;

2) Schematic: Automatically activated and made up of associations learned during the neonatal age, on the basis of which image-like prototypes of emotional situations are formed, integrated with innate sensorimotor responses and acquired ones;

3) Conceptual: has content, includes memories, expectations, aims, etc.

For Leventhel and Scherer, these three levels operate in parallel in adults, and at each level a series of evaluative "checks" are carried out on the stimuli, to check for novelty, pleasantness, relevance, coping potential, etc.

The most characteristic component of Scherer's concept (2009) is the process of appraisal of information from the external environment.

The process of appraisal is analysed by Scherer in great detail and implies, for example, the recognition of the importance of an event, its pleasantness, its degree of novelty with respect to our expectations of the world, whether it hinders or promotes our goals, the possible presence of someone to govern it, our ability to manage it, its significance within our value system. Typical and distinctive of Scherer's approach is that the sequence in which these evaluations take place is identified.

It is therefore of fundamental importance, in order to design and implement effective assessment and observation protocols, to develop processes to monitor the Arousal of the users with whom one works in a stimulating environment, tuning into the emotional experience. Observation is configured as a tool through which to exercise a cognitive and "control" function with respect to the proposed psycho-educational intervention. It must be carried out with method (i.e. with rigour and critical sense), intentionality and systematicity, thus assuming the characteristics of a systematic observational research (Vannini, 2019). One does not observe with the aim of exploring an already known situation, recording information that is

already known to us: one observes when one is in the presence of a cognitive need, when, with respect to a new situation, one needs to grasp characteristics and/or internal dynamics.

In the systematic observation of behaviour, two dimensions are fundamental: repeatability (the condition in which independent test results are obtained with the same method on the same subject, in the same environment, by the same operator, in short time intervals) and reproducibility (the agreement between the results of measurements carried out under different conditions, therefore by a different operator and/or with one at different times). An increase in variability also leads to a decrease in reproducibility. The accuracy of the measurements is determined by the degree of agreement between the results of the observations (Morsanuto, Tafuri, 2017).

Conclusions

As described, the aim of this work is to analyse the neuroscientific activation processes of arousal, explaining their important implication in emotional experience. Observing the state of activation at the entrance to the multisensory room allows to better define the stimulation protocol designed for the user. It is therefore essential, given the proposed studies, to develop observation and evaluation plans that allow rapid monitoring of the person in order to adapt the intervention protocol to his or her 'mood'. The emotional system in fact, acts as a connection in the mediation between all the actors: user, educator, but above all environment (Di Maglie, 2020). It will also be important to verify the effectiveness of the design of the stimuli in response to the observation of the arousal and the reactions actually obtained.

As shown by the research of Chitsey et All (2020) sessions in the multisensory room produce well-being and reduce "problem behaviours". The authors note that few studies have yet evaluated the effectiveness of specific elements and the link to the unique sensory needs of individuals. Their study describes the creation and evaluation of a sensory hub for students with disabilities and distinct sensory profiles in a Chicago public high school. The hub supports a wide range of atypical sensory processes in neurodiverse individuals. Data were collected during one academic year using surveys, focus groups, field observations, sensor data, access cards, and student records and allowed for the mapping of sensory affordances in relation to users. Based on the results of the study, suggestions were made for the design of sensory hubs in other learning environments. The foundations laid with the developments of this work will allow studies to be repeated in other educational and didactic contexts, promoting a culture of bio-psycho-educational multisensory interventions, with particular attention to observation and intervention on the users'/students' arousal.

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