

Virtual Communication and its Negative Impact on the Generation of Creative Ideas

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Abstract

During the Covid-19 pandemic, the global scenario changed and the people had to adapt to social isolation, which led to an increase in the utilization of remote technologies in multiple areas. Although remote classes and meetings helped during the pandemic context, it also negatively impacted on the generation of creative ideas because of the contact restriction and the consequent decrease in visual focus. Furthermore, creativity depends on multiple neuronal systems and networks that result from the communication between the two brain hemispheres, which are influenced by external stimuli. The present article exposes a narrative literature review on the analysis of scientific articles published between 2015 and 2022, in PubMed, about the impact of video-conference in the academic creative process, in the COVID-19 pandemic scenario, using the terminology indicated by the System of Descriptors in Health Sciences (DeCS) and a set of predetermined criteria to select the best articles on the subject. The divergent and the convergent thinking influence directly in the generation of creative ideas, aiming to achieve something useful and original. Also, creativity depends on multiple brain areas and networks, such as the default mode network, executive control network and the salience network. Therefore, creative idea generation depends on multiple factors that are still not fully comprehended by neuroscience and it is negatively affected by virtual interaction, which confirms that presential events cannot be replaced by video conferences and online substitutes without harm.

Introduction

During the Covid-19 pandemic, there was a sudden change in the global scenario in multiple areas, mainly in labor and student activities, in which the population had to adapt to the changes imposed by social isolation, reaching for a most frequent use of remote technologies, aiming to avoid the suspension of its activities. This reality legitimated even more the growing movement of home office in the last decade. In this context, the digital resources, such as Google Meet, Zoom, Skype, Microsoft Teams, amongst others, have had perfecting of the technological tools due to the growing users' demand in order to adapt to this new reality [1]. Thus, to minimize the great rupture in conventional education, teaching institutions used these resources to continue the academic activities, which provided an effective communication between students and professors [2], but also led to the decrease of visual focus,

causing negative impacts on the generation of creative ideas [3], which is a necessary contribution to learning in the academic environment. The process of transmitting knowledge, however, does not restrict itself only to conventional study abilities [4], but also needs alternatives to the traditional methods, such as mind maps and problem-based learning (PBL), to reach more creative results [5]. Another factor that contributed to such impacts was the restriction of contact through the screen. Some studies came to the conclusion that, while the virtual communicators restrict its visual scope to a screen shared environment, its cognitive focus is also narrowed. Therefore, creativity is a sociocultural phenomenon that results from a complex interaction of the individual's variables with the environment it is inserted in [6].

In the decade that preceded the Covid-19 pandemic, changes in

the communication technology scenario had already been noticed, however, before this context, distance interactions were still limited to the most common means in that period, such as letters, text messages, e-mails, amongst other asynchronous technologies that made the information exchange difficult. However, since the pandemic context, some synchronous collaboration technologies have gotten bigger proportions [3], which made possible the execution of online classes and remote labor, providing greater resemblance with the live means, aiming to create educational alternatives to look like an environment that was not possible given the historic moment [1,3]. Digital technologies evolved greatly with the goal to maintain teaching activities and administrative routines, however, in some points, it has become evident the impossibility to completely substitute the live context [3].

The creativity and the production of creative works depend on different neuronal systems, which result of the communication between the two brain hemispheres and participate in different activities, whose intercommunication is done through the corpus callosum, possibilitating the simultaneously of the activities mediated through the hemispheres and the consequent development of new ideas, as well as motor abilities, visual attention and perception [7-9]. These factors cannot be broadly reached in the virtual environment, even with the technology advent, which result in a process that does not completely reach the construction of creative ideas as much as they are obtained in a presential environment [3], leading to a low educational performance [1]. The decrease of visual focus and the consequent loss of peripheral stimuli also diminish the cognitive focus, impacting on the generation of new creative ideas [3]. Thus, video conferences, even getting proportions of extreme importance, still left blanks that cannot be occupied by technologies, since the presential environment brings significant benefits in which concerns the creative process, which is essential for the society's development [8,10].

Furthermore, it is worth mentioning the socioeconomic differences evidenced during remote teaching, in which the students in the most privileged economic class had greater support in the studies mid-isolation, in comparison to the students that come from low or medium income families. While the students from wealthy families kept working in abilities that would be

beneficial in the academic environment, the students from economically disfavoured families were harmed in the execution of these competences. This happened because the approach of the educators in the distinct realities was marked by disparities, given that students from the wealthiest institutions had greater accessibility and contact with the professors, whilst the students from the educational networks with less economic power were harmed, due to, many times, not having access to the necessary technological means, such as broadband or computers [4], and not having contact with the broad knowledge in the digital world, because of the limited access.

According to what was discussed, it is concluded that the education through video conferences has unfavorable points, highlighting the negative impact of virtual means on the generation of new ideas. The fact that the creative process can be influenced by an interaction between the variables of the environment the individual is inserted in can explain the negative impacts previously addressed. Thus, it is noted that although the remote teaching has been a plausible and necessary alternative in the pandemic context, the virtual modality is not capable of substituting live classes, due to the social isolation, difficulty to interact with professors and other colleagues, diminished motivation and interest in studying, decreased access to internet and to technological tools, such as computers and cellphones, which interfere in the learning process and, consequently, in the full creativity reach.

Methods

The present article exposes a narrative literature review based on the analysis of scientific articles published between 2015 and 2022, in PubMed, about the impact of video-conference in the academic creative process, in the COVID-19 pandemic scenario.

The utilized criteria to select the first set of articles excluded the titles that did not address the themes “creativity” “video conference” and “remote teaching”, articles that were not inserted in the publishing period between 2015 and 2022 and articles that were not written in English. In the PubMed database, the utilized keywords were “(neurology) AND (creativity)”, which led to 384 articles found, of which 20 were selected; “(creativity) AND (video conference)” whose search resulted in 27 articles found, of which 5 were selected; and “(remote

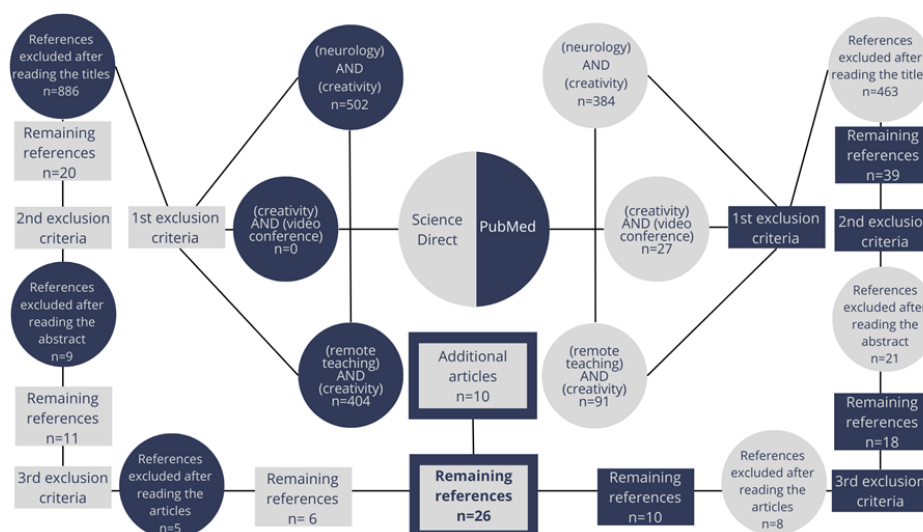


Figure 1: Flowchart addressing the stages of selection and exclusion of the articles.

teaching) AND (creativity)” which resulted in 91 articles found and 14 selected articles.

In the Science Direct database the same keywords with the filter of articles published from 2021 to 2022 were utilized, when applied with “(neurology) AND (creativity)” found 502 articles, of which only 1 was selected after the exclusion of articles that had been selected in PubMed and of those that did not address the theme; “(remote teaching) AND (creativity)” found 404 articles, of which 19 were selected by the title; and the keywords “(creativity) AND (video conference)” did not find results in the Science Direct database in the period between 2021 and 2022.

In the second set of applied criteria, the articles whose abstract were not addressing the creativity and the relation that remote teaching, through video conferences, caused in the creative process, as well as the articles that direct to a specific health condition, were excluded, totalizing 21 articles in PubMed; and 8 articles from Science Direct.

Finally, after the third set of criteria was applied, the reading and analysis of the complete articles were executed, selecting 10 original articles in English from PubMed, 6 original articles in English from Science Direct and 10 additional articles were maintained in the literature review, totalizing 26 articles.

Neural Mechanisms Underlying the Generation of Creative New Ideas

Creativity is involved in almost every aspect of life and can be defined as the ability to change existing thought patterns, as well as flexibilize and break the lines of thought construction [11]. Thus, the generation of creative ideas allows the society development and its evolution through numerous means, amongst them, for possibilitating the prolongement of life and the decrease of suffering [7]. In this context, the neural mechanisms involved in creativity are being broadly studied by neu-

rosience [12], although they are still not completely comprehended [11] it is known that creativity involves complex and non-linear neural dynamics [13].

A study suggests the division of creative thought in 4 stages, them being: preparation, incubation, illumination and verification, in which the preparation stage is based on the acquisition of knowledge and abilities that will allow the individual to explore its creativity. The incubation happens in the moments in which the individual thinks and reasons, unconsciously, about how he can develop that product, being the divagation an important ally in the creative process. The stage of illumination is not a factor separated from the process, but being conscious that the idea was reached. Whilst the process of verification happens through the experiment of that idea, the result of this process in fact reaches the desired performance [7].

Amongst the factors that are being studied and that are well comprehended as important for generating new ideas, are the pre-existent recuperation processes of others and the creation of new ideas [12], as well as the importance of divergent thinking in which concerns the idea’s originality, which applies as the most important point in the generation of creative thought when it facilitates the creation of an idea for problem resolution [14]. Another factor that is part of creativity and adapts itself along with divergent thinking is the convergent thinking, which, although its emphasis is turned to utility, makes itself fundamental in creativity, since it organizes the thought considering the applicability and adaptability of the idea to real life [14]. Understanding that the divergent thinking presents vague possibilities of solutions and the convergent thinking singular and well-defined answers, it becomes possible to attribute the stages one and two of creative thought, to the divergent thinking and the stages three and four of the creative thought, to the convergent thinking [29].

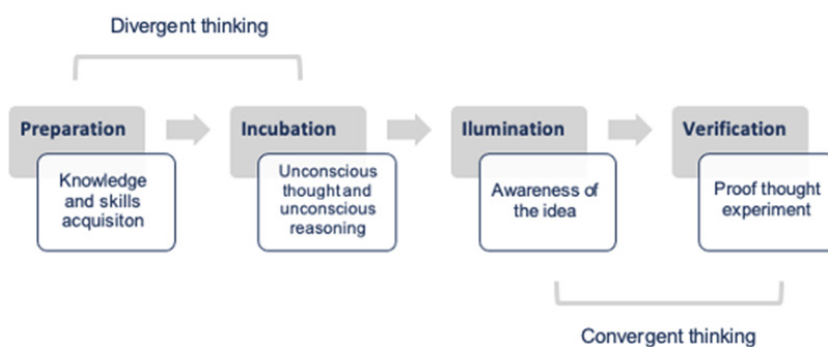


Figure 2: Flowchart addressing the Neural Mechanisms Underlying the Generation of Creative New Ideas.

Creativity can be a complex function, it does not depend on a single action site in the brain. In contrast to that, it is believed that creativity is associated with interaction, reorganization and alternance of the functional brain networks of great scale, such as the default mode network, the executive control network and the salience network. Thus, more creative individuals would be capable of frequently reconfiguring the brain networks and, therefore, promote more flexible interactions, regionally and globally [30,31]. Consequently, the operation of every neural network and the way they relate simultaneously are determinant in the creative process. The default mode network mediates the spontaneous cognition and contributes to the divergent thinking through the capacity of memory recuperation and idea

generation [31]. Thus, studies correlate the creative capacity and reverie episodes (“daydreaming”), which in excess demonstrate negative influence in creativity, due to the activation of similar regions inside the default mode network [32]. The salience network works as a filter of useful and new ideas and alternates between the default mode network and the executive control network. The executive control network restricts the stream of consciousness to a specific objective and aims to maintain the attention in the evaluation of ideas [31]. Due to this alternance, the default mode and the executive control networks, which usually present an antagonist relationship, tend to cooperate in the enhancement of creative cognition [33]. The neural mechanisms that participate in the generation of new

creative ideas are mainly related to the processes that permeate the divergent thoughts, which, in general, are associated with an extensive activation of the left prefrontal cortex and right medial temporal lobe along with the desactivation of the right temporoparietal junction [12], which is associated with the individual's capacity to orient its attention to a new stimulus [15]. This exemplified correlation makes possible the understanding that creativity and production of creative works depend on different neuronal systems, which result from the communication between the two brain hemispheres, that participate in different activities, whose intercommunication happens through the corpus callosum, possibilitating the simultaneousness of the activities that are mediated by the hemispheres and the consequent development of new ideas, as well as motor abilities, visual attention and perception [7-9].

Few studies analyze the white matter when related to creativity. However, the relation of the enhanced anatomic integrity of the white matter in different areas, including the prefrontal cortex and the corpus callosum, showed a significant creativity increase, for enabling more cognitive control in the frontal lobes and information integration between the hemispheres when analyzed in the corpus callosum [13].

The search to comprehend the neural mechanisms that involve the generation of creative ideas still did not precisely find all the neural processes linked with this ability. It is known that creative people have less marks in their dominant hemisphere, while less creative people own more marks [9], and that the left hemisphere is still necessary for executing artistic works [9], even when there is the dominance of each hemisphere to certain activities, such as the right hemisphere being specialized in metaphorical thought, ludicity, search and solution synthesis, and for being the center of visualization, imagination and conceptualization [9].

Brain Activation Related to Divergent Thinking

Creativity can be defined as the capacity to form through two or more distinct and isolated ideas a new one that is innovative, original and coherent, "Ability to find union in what seems to be diversity" [7,11]. Besides, it is described as the set of two types of thinking, divergent and convergent [14,17].

Divergent thinking can be considered an useful tool for abstract ideas, in different ways, which makes it possible to observe different purposes for something that would be commonly used for a single specific function. In contrast, convergent thinking has shown itself useful to identify and select the best ideas amongst the available in a more racionalized way. In the creativity process, divergent thinking is observed more intensely in the early stages, as schemes and abstract thoughts, whilst convergent thinking becomes more present in the final moments, in which there is a synthesization and organization of ideas from divergent thinking. Besides, divergent thinking can be understood as an integrant of the originality process, whilst the convergent is more associated with utility [7,11,14,17].

From a topographic point of view, it is possible to infer, through the analysis of recent studies, as Takeuchi et al (2010), that the frontal lobes are of great relevance for the synthesis of divergent thinking; Thus, it was certified that the dorsolateral frontal lobe, mainly in the right hemisphere, is related to the divergent creative cognition. Furthermore, the lateral frontal lobes, as well as the left prefrontal cortex and the right medial temporal lobe, along with simultaneous deactivation of the right temporoparietal junction, are essential for the reasoning divergence and for disengagement. These two attributes together are fundamental for the beginning of the creative innovation process. It is also known that the reward system of the ventral striatum is activated in more creative people, due to, for example, the search for novelty and the greater tendency to take risks. Moreover, highly creative people can present anatomic alteration of specific neocortical areas [7].

The creative cognition in works of divergent and convergent thinking is articulated by metacontrol dispositions, which is exemplified by the Dual Pathway to Creativity Model (DPCM). In which there are two pathways to reach creativity: a flexibility and a persistence pathway. These two dispositional and situational conditions corroborate in a different way in the divergent and convergent thinking: the flexibility route can dominate the divergent thinking and alternate between different categories, whilst the persistence route can dominate convergent thinking or the production of different items of the same category in divergent thinking [27,28].

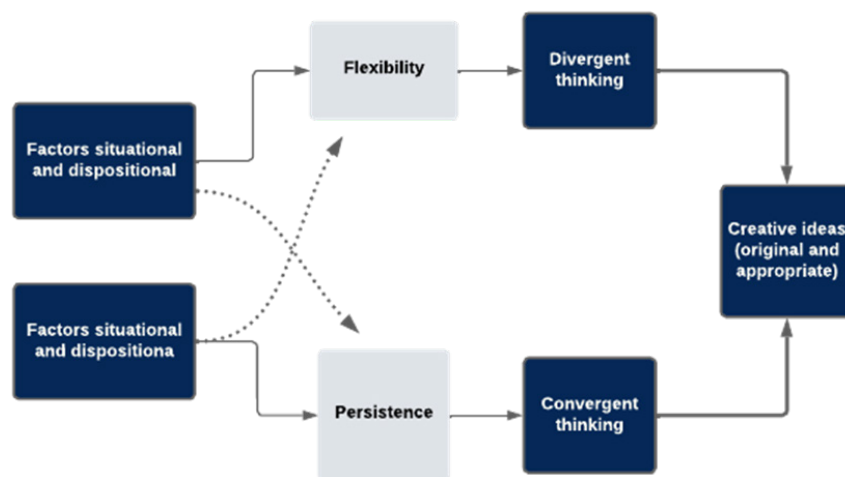


Figure 3: Flowchart addressing the dual pathway to creativity model relating the divergent and convergent thinking.

According to **Nijstad et al. (2010)** [28]. In which there are two situational and dispositional pathways that affect with greater intensity the flexibility pathway than the persistence pathway or vice-versa, the dotted line represents weaker relations.

Thus, it is noted through the revision of works that cognitive flexibility is related to the originality of the idea, although this originality can also include contents of great depth as persistence factors [27]. Together, divergent thinking or the capacity to comprehend, intuition or knowledge (“insight solutions”) in works of convergent thinking seem to benefit of metacontrol biases in direction to flexibility, whilst convergent thinking, seems to depend on metacontrol routes in direction to persistence [27,28].

Regarding the metacontrol routes, the activation of positive and negative mood states have been associated with the creativity increase, in which the activation of positive moods stimulate the flexibility related to divergent thinking, whilst the activation of negative moods can enhance the creativity when stimulating persistence [27,28].

According to that, divergent thinking allows new ideas to be generated in a context in which more than one solution is correct. Furthermore, to measure the divergent thinking capacity of people four indicators are currently utilized for the evaluation of the performance in the Alternative Uses Task (AUT), the variables evaluated are: fluency (number of generated ideas); flexibility (number of categories utilized by the patients); elaboration (number of details provided); and originality (number of single and original answers in relation to the total sample). Of these four indicators, flexibility is the most transparent, once it qualifies the idea production, dividing the quantity of ideas generated by the number of different categories [27].

Studies utilizing magnetic resonance showed activation of different parts of the brain during the creative stimulus, but there was no consistency in the results [14]. Furthermore, it was observed that during the creative process both brain hemispheres were activated, in which one side had greater aptitude for the cognitive process, whilst the other, the left one, executed the divergent thinking more efficiently, being the creative process an interaction of both hemispheres [7,14].

Furthermore, it was observed that intelligence evaluating tests, such as the IQ, tends to measure what was learned by an individual, as well as the rescue of the accumulated knowledge. Thus, it is clear that such evaluative dynamics prioritizes the convergent cognitive processes in detriment of the divergent, in a way that the creative processes are not properly quantified by these tests. Tests such as Stroop Test e Wisconsin Card Sorting, which evaluate disengaging, and Alternative Uses and Torrance Test, associated with divergent thinking parameters, seem to be more trustworthy in which concerns the creative process evaluation [7].

A comparative study was conducted in epilepsy patients that went through the callosotomy surgery, in which a separation of the corpus callosum is executed to avoid communication between the hemispheres, avoiding that convulsions flowed from one side to another, and when comparing the creative ability of the patient before and after surgery, a decrease was noticed post-surgery [7,14].

Furthermore, there was a study that aimed to analyze the differences between twins in the construction of the creative process, and it could be observed that men had greater ability to develop original ideas, while women could develop ideas with greater capacity of adapting, to adequate more easily in the necessary context. Regarding the neurologic mechanisms, in relation to creativity, there was no difference in brain activity [18].

Thus, the generation of creative ideas demands complex cerebral mechanisms, where there is a combination of divergent and convergent thinking in which one will be responsible for the process of creating ideas and the other will act in organizing them. Besides, there is a necessity of bilateral activation of the brain for the creative ideas to be synthesized [7,11,14,17].

Virtual Communication Curbs Creative Idea Generation

A creative idea consists of the formulation of a thought that involves originality or novelty, which adapts itself to the desired purpose [19]. Accordingly, the process of idea generation is directly influenced by the social interactions [2], since creativity is a sociocultural phenomenon that results from a complex interaction of the individual’s variables with the environment [6]. Thus, virtual communication restricts creative production because it stimulates a narrowed cognitive focus and limits social conviviality [3,20].

At first, virtual communication makes the creativity process harder due to the cognitive focus decrease. This occurs due to the necessity to narrow the field of vision to a screen, leading to the adaptation of the cognitive focus that restricts the associative process responsible for the branching of the thoughts and the activation of numerous information that are incorporated to form new ideas. Thus, even if there is a screen replacement for bigger ones, it will not result in a better performance, because the problem is related to the focus on the screen and filtration of the peripheral visual stimuli [3].

Furthermore, the limitation of social interactions resulting from the video conferences is a favorable factor to the inhibition of creative ideas, since the visual contact between people is not possible, making the creation of a synchrony between the individuals’ brains hard. In this context, this distancing is harmful, because social contact is important in the identification of necessary restrictions to orientate creativity through sharing different perspectives [20].

In addition to that, during the last 2 years, marked by the Covid-19 pandemic, due to the impossibility of presential meetings, there was a noticeable development of digital platforms, mainly of the synchronous audiovisual technologies [3,21,22]. This scenario, however, evidenced the socioeconomic differences, in which unfavoured people had more adversities in the process of idea generation, because, besides the points cited previously, these individuals did not have digital resources and enough space for teleworking [22-26].

Therefore, due to the creativity restriction resulting from virtual communication, the virtual modality is not capable of fully replacing the presential. However, a possibility to minimize these impacts on the institutions that are functioning virtually or hybridly would be to prioritize the generation of creative ideas during presential meetings aiming to enable the important interaction between the individuals and the environment

[3].

Another aspect to add, is the fact that video conference meetings allow the participants to alternate focus with numerous distractors. When deviating the attention to other information, such as text messages, pictures or videos, we activate the central executive network related to attention and immediate memory. Thus, the fact that we are actively involved in an activity that demands attention or a task directed to objectives, we keep the central executive cognitive network activated, which automatically deactivates the functioning of the default mode network [34].

The default mode network, highly related to activities such as thinking about yourself, engaging in certain types of social cognition, imagining past or future events, creating a spatial scene in imagination (35). It can also be related with the creative thought process [36].

Conclusion

According to the information exposed, it is noticed that creativity is related to many factors that are still being discussed by neuroscience, whose mechanisms are still not completely comprehended. Amongst the findings that carried more scientific evidence are the necessity of integration between the two hemispheres for the formation of new ideas, and the fundamental role the divergent thinking has in the generation of creative ideas, specially in what concerns the originality, being also important to combine it with convergent thinking that will organize and direct the generation of creative ideas, which has great utility in the real life context.

Besides, it can be verified that virtual communication makes the process of creative ideas generation harder due to the decrease of cognitive focus and to the restriction of the interactions with the environment that are of great importance for the development of many cognitive competencies necessary for the viabilization of full creativity.

Conflict of Interest: The authors declare that they have no conflicts of interest. All authors read and approved the final manuscript.

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