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Abstract

Visual distraction is widely studied in children, particularly in visuospatial cognitive tasks. In these studies, targets and distractors are usually shown in the same display (e.g., the computer screen). However, children are constantly exposed to visually enriched environments (e.g., elementary school classrooms), and little is known about their influence on children's cognition. Although the importance of the surrounding environment is well recognized in the literature, few experimental studies have explored this question. We propose an alternative paradigm to study visual distraction in children that brings together the rigor of experimental psychology and more ecological validity on the exposure to potential environmental distractors. Our study was designed to investigate whether a high-load versus a low-load visual surrounding environment influences children's cognitive performance as evaluated by four different cognitive tasks. A sample of 64 children (aged 8-12 years) completed two sessions in two environmental conditions: high-load visual surrounding environment and a low-load environment. In each session, they performed visuospatial attention and memory tasks. Overall, the results suggested that the high-load visual environment affected children's cognitive performance given that children performed better in the low-load visual environment (e.g., higher percentage of hits, higher Corsi span). Understanding the impact that a visually rich surrounding environment has on children's cognitive processes that support more complex ones is important to support recommendations on how the environment should be organized to foster better daily activities.

Keywords: visual distraction; environmental distraction; high-load visual environment; low-load visual environment; visuospatial attention tasks; visuospatial memory tasks

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Introduction

An increasing number of studies have been concerned with the influence of the surrounding environment in several contexts, particularly in learning settings (e.g., Fisher, Godwin, & Seltman, 2014); for example, children learning environments typically display many colorful materials. Although these stimulating environments are designed to provide sensory enrichment during early phases of development and to motivate pupils to engage in learning activities (Barrett, Davies, Zhang, & Barrett, 2015), little is known about their real effect in cognitive processes that underlie other activities. Some authors have considered that such environments are "excessively stimulating and disrupting" (Stern-Ellran, Zilcha-Mano, Sebba, & Levit Binnun, 2016, p. 1) and can become a source of distraction (Godwin et al., 2016). Indeed, at a given moment, whereas some of the available stimuli migth be relevant to the task at hand (targets), others are irrelevant and may work as distractors (Forster & Lavie, 2014). Attending and processing all visuospatial stimuli is impossible due to our limited processing capacity; this is specially true in children whose cognitive processes are still developing (Gaspelin, Margett-Jordan, & Ruthruff, 2015).

Most of the studies that have investigated visual distraction have used laboratorial paradigms in which both distractors and targets are presented in the same display, usually the computer screen (e.g., Gaspelin et al., 2015). From a theoretical standpoint, several cognitive processes seem to be involved in the processing of visuospatial information such as selective attention and working memory, two executive functions that interact in a bidiretional manner (Dixon, Fox, & Christoff, 2014). Working memory has been conceptualized as the interface between oriented executive control (endogenous attention) and stimuli-driven control (exogenous attention) and is considered a central agent in controlling for the interference of distractors (e.g., Konstantinou, Beal, King, & Lavie, 2014). In typical selective attention tasks, the capacity to ignore distractors depends on the level of perceptual load; distractors' interference is greater when these differ from the target stimuli (as compared with when they are similar), a situation that requires a higher involvement from working memory (e.g., Konstantinou et al., 2014).

Although laboratory-based procedures are relevant, they might not reflect the potential influence of the surrounding environment present in children's daily lives. The environment-behavior model proposed by Barrett et al. (2015) provides a framework to better understand the environmental factors that could influence children's performance in several contexts such as classrooms. According to this model, there are three main environmental factors that influence learning gains: naturalness, individualization, and level of stimulation. The first refers to the idea that performance could be improved when individuals are linked with natural elements such as plants or pure air. The second denotes that children's performance (e.g., learning) is influenced by their own location in the environment (e.g., classrooms) and/or by their connection with the remaining people (e.g., learners). The level of stimulation relates to the color and the complexity of the visual environment. Of main interest to the current study is the last element, which has also been considered in some studies (Fisher et al., 2014; Hanley et al., 2017; Mastroberardino & Vredeveldt, 2014; Stern-Ellran et al., 2016).

Fisher et al. (2014) investigated the impact of the classroom visual environment on children's ability to focus their attention during lessons and to learn their contents. Children (N = 24, M_{age} = 5.37 years) participated in several lessons over 2 weeks. Half of the lessons occurred in a decorated classroom, and the remaining in a sparse classroom; lessons were video-recorded. The decorated classroom consisted of a laboratory space containing several visual elements that were potential distractors and usually found in elementary schools (e.g., posters, maps). The sparse classroom was the same space but without these stimuli. The order of the environmental manipulation was alternated among lessons, with the first one always occurring in the sparse classroom. After each lesson, learning gains were assessed via paper-and-pencil tasks and compared with the pretest evaluations. The results revealed a decrement in learning gains when the lessons occurred in the highly decorated environment. Participants were also more distracted and spent more time off-task in the decorated classroom than in the sparse classroom, as revealed by the analysis of the video-recordings.

Stern-Ellran et al. (2016) explored the effect of a colorful vs. a non-colorful surface on children's structured play. The first one consisted of a surface covered with paper decorated with several images and colors, whereas the second one was a stand covered with a white paper. Children (N = 15, M_{age} = 44.10 months) performed three typical preschool games individually in each of these conditions in two separate video-recorded sessions. The order of the conditions was randomized across participants, but the order of the games was the same for all children. The results indicated more disruptive behaviors, such as staring away, emitting vocalizations, and missing pieces of the game, in the colorful surface condition than in the non-colorful surface condition.

The authors concluded by speculating about the potential effect of the surrounding environment on attention, perception, and other cognitive processes. However, this study did not include any assessment of these specific processes.

Hanley et al. (2017) recently explored the effect of visual displays on attention and learning in children with and without autism (M_{ages} = 10.6 and 9.0 years, respectively). Each participant individually completed three sessions; in the first session participants completed a set of cognitive measures, in the second they watched two videos of a storybook read-aloud task, and in the third they watched two videos of mini-lessons. Importantly, in each of these sessions, one of the displayed videos had been recorded in a high-visual-display condition (i.e., a visually distracting background with visual elements from a primary school), whereas the other video had been recorded in a no-display condition (i.e., the same background but without the visual elements). The order of the background manipulation was counterbalanced, but the order of the tasks (storybook and mini-lesson) was fixed. Children's eye movements were recorded by eye-tracking during the visioning of the videos, and worksheets were administered after the mini-lessons to assess learning. All participants presented lower learning scores in the high-visual-display condition than in no-display condition; this effect was higher in the autism group. The reduced learning scores in the high-visual-condition was justified by the allocation of attention to the colorful background as measured by eye-tracking; this distractive behavior was found in all participants, but mostly in children with autism.

The impact of the surrounding environment has also been considered in other settings, although with a slightly different procedure. In a study on forensic psychology conducted by Mastroberardino and Vredeveldt (2014), a group of 120 children aged 8-11 years participated in cued-recall eyewitness interviews after watching a short clip with a series of events. Each participant performed the interview in one of four conditions: black screen, eye closure, visual distraction, or auditory distraction. In the first condition participants looked at a television black screen while responding during the interview, whereas in the second condition they responded during the interview with their eyes closed. In the visual and auditory distraction conditions, during the interview, participants were instructed to look at the screen where visual stimuli appeared (written Hebrew words), and to listen to auditory stimuli (spoken Hebrew words) while looking at the black screen, respectively; the distractors were not related to the content of the video clip. Participants from the eye closure and the black screen conditions provided more correct and fewer incorrect responses about visual details of the video clip than children from the visual and auditory distraction conditions. The researchers argued that this pattern of results occurred because the interference of the environmental distractions was minimized in the black screen and eye closure conditions, which facilitated the retrieval of information.

Overall, the results from these studies indicate that children could have difficulty in ignoring visual distractors when these are embedded in the surrounding environment. Although these previous studies assumed that the effect of the visual environment on complex tasks occurs through basic cognitive processes, they did not test this possibility directly. Moreover, we identified some procedure details (e.g., the counterbalanced order of the environment and tasks) that were not accounted for in these studies (e.g., Fisher et al., 2014).

To the best of our knowledge, only one study has investigated the effect of the visual surrounding environment on the performance of basic cognitive processes, but in older adults (Rodrigues & Pandeirada, 2015). In that study, 40 older adults (M_{age}=72.98 years) performed two experimental sessions (interval of 14-21 days): one in a high-load surrounding environment and the other in a low-load surrounding environment. In the former several visual elements were displayed on the wall in front of the participant (e.g., posters, photos), whereas in the latter the wall contained no visual elements. In each session, the participant performed two visual attention tasks and three verbal working memory tasks. The order of the tasks and environment was counterbalanced across participants. The results revealed worse performance when the tasks were completed in the high-load visual surrounding environment as compared with the low-load visual surrounding environment, predominantly in the two visual attention tasks. Following the literature suggesting that older adults have difficulties in ignoring distractors embedded in their external environment, possibly due to deterioration of their cognitive functions (Craik & Bialystok, 2006), the authors suggested that the high-load condition was potentially more distracting than the low-load condition.

The current research aimed to investigate the potential effect of the visual surrounding environment in four different cognitive tasks in children aged 8-12 years, an active period of development of cognitive functions in which children seem to be particularly susceptible to visuospatial distraction (e.g., Vuontela et al., 2013). To this end, 64 children performed two experimental sessions in which the visual surrounding environment was manipulated. In one session participants were exposed to a high-load

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visual surrounding environment, and in the other session they were exposed to a low-load environment. In each session, participants performed a set of visuospatial cognitive tasks. We focused on tasks widely used to assess visuospatial inhibition, response selection, and memory; these cognitive skills are crucial in children's interaction with their surrounding environment (e.g., Vuontela et al., 2013). Following previous studies, we predicted that children's performance would be worse in the high-load visual surrounding environment as compared to the low-load environment. On an exploratory note, we also looked at sex differences and at the relation between performance and age. We expected to find no differences between sexes, and we predicted that performance would improve with age.

Method

Participants

Our sample consisted of 64 Portuguese children aged 8-12 years (32 girls; M_{age}=10.16, *SD*=1.36). They were recruited from two groups of schools in the Aveiro district of Portugal. Written informed consent was previously obtained from the children's guardians. Children also expressed their agreement to participating and were informed that they could withdraw from the experiment at any time if they wanted to do so. None of the children who participated suffered from neurological, psychological, or learning disorders according to the information provided by the children's guardians and teachers. Data of 1 child were not included because the second session occurred outside of the predefined time interval.

Materials

Sociodemographic questionnaire: This brief instrument included sociodemographic questions (e.g., age, sex) that allowed us to characterize the sample and evaluate possible exclusion motives. This was completed by the children's guardians.

Cognitive tasks: Children performed four visuospatial cognitive tasks: two attention tasks (*go/no-go* and *choice reaction time*) and two memory tasks (*Corsi block-tapping* and *Rey Complex Figure* [RCF]). The attention tasks were programmed and run by the software E-Prime 2.0 (Schneider, Eschman, & Zuccolotto, 2002). The Corsi block-tapping task was applied in a computerized version (PEBL [Psychology Experiment Building Language]; Mueller, 2012) and the RCF was administered in a paper-and-pencil format (Rey, 1988).

In the go/no-go task (e.g., Steele et al., 2014), the letter *X* or *K* was randomly and singly presented on the computer screen for a maximum of 600 ms (time window to respond). A fixation cross preceded each letter for 500 ms. The intertrial interval was pseudorandomly selected from among the following: 500, 1000, 1500, or 2000 ms; each occurred the same number of times during the task. Each participant was instructed to press on the “white” key (a white sticker was placed on the spacebar keyboard key) as soon as possible when the letter *X* (go stimulus) was presented on the computer screen and not to respond when the letter *K* (no-go stimulus) was exhibited. The go and no-go stimuli were presented in 66% and 34% of the trials, respectively. After starting with 12 practice trials, children completed 140 experimental trials.

In the choice reaction time task (e.g., Woods, Wyma, Yund, Herron, & Reed, 2015), children were instructed to respond as quickly and accurately as possible to the red rectangle by pressing the “red” keyboard key and to the green rectangle by pressing the “green” keyboard key. Red and green stickers were placed on the keyboard keys Q and P, respectively, to facilitate responding. Each color was randomly exhibited on the computer screen 50% of the time for a maximum of 600 ms (time window to respond). The intertrial interval was one of the following four: 1000, 1500, 2000, or 2500 ms (pseudorandomly selected the same number of times during the task). A pre-fixation cross (500 ms) preceded each colored rectangle. Each participant started the task with 12 training trials and then completed 140 experimental trials. Schematic illustrations of the attention tasks are provided in Supplementary Material (SM) 1 in the online supplementary material.

In the Corsi block-tapping task, nine blue squares appeared on the white screen of the computer. In each trial, some squares lit up (in yellow), one per second, creating a sequence. Children were instructed to repeat the same sequence, clicking on the squares in the same order they lit up (*forward span*) using the computer mouse. The number of lit squares in each sequence increased after 2 trials of a given extension: the first 2 trials included the lightning of two squares, the following 2 trials consisted of the lightning of three squares, and so on. When the participant failed to reproduce the sequence accurately on the 2 trials of the same length, the task ended automatically (Mueller, 2012).

In the RCF (Rey, 1988), the copy and immediate recall[1] tasks were administered. In copy recall, children were instructed to copy the RCF in a paper sheet with the presence of the figure stimulus. In immediate recall, 3 minutes after the conclusion of the copy, participants were asked to reproduce the RCF on another paper sheet, but this time without the presence of the figure stimulus (see SM 1 for more details).

Environmental conditions: Two environmental conditions were created: a high-load visual surrounding environment and a low-load environment[2]. The first consisted of a white stand displaying several visual elements, whereas the second consisted of a replica of this stand without any visual elements. The pictures used in the high-load environment were subjected to a previous pilot study (see SM 2 for detailed description); we opted not to use education-related materials because we wanted to test a broader potential impact of the surrounding environment. In the two conditions, the stand was placed on the table were the four cognitive tasks were performed (Figure 1).

A **B**

Figure 1. Illustration of the two visual environmental conditions: (A) High-load visual surrounding environment; (B) Low-load visual surrounding environment.

Procedure

Following a within-participant design, each participant attended to two sessions at about the same time of the day, one in a high-load visual surrounding environment and

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[1] Copy was administered as a requirement to immediate recall. The later assesses visuospatial working memory (among other cognitive abilities).

[2] The designations of the two conditions were given only to differentiate the two environments because we did not objectively assess visual load. We should also note that the load concept is difficult to objectively quantify, as mentioned by Murphy and Greene (2016).

the other in a low-load environment, with an interval between 14-21 days. The order of the environment and cognitive tasks was counterbalanced across participants (see SM 3 for details). All sessions occurred in a quiet room of the school being attended by the participant. Given that the cognitive tasks were of visuospatial nature, at the beginning of the first session we conducted a short visual screening and stimuli recognition task. In this task, several colors and letters were presented on a paper sheet, and children were instructed to simply name each stimulus. No participants were excluded due to failure in this screening. Other self-report measures which did not interfere with the environment manipulation or with the cognitive tasks were applied before and after performing the cognitive tasks; these are not addressed here as they do not relate to the goal of this work.

Data Analysis

Paired *t* tests were used to examine the environmental effect (high load vs. low load) in performance. In the go/no-go task, the variables of interest were the hits, the false alarms, and the reaction times for hits. In the choice reaction time task, we looked at the correct responses, the errors, and the reaction times for correct responses. Corsi span was the variable from the Corsi block-tapping task, whereas total scores were considered in the RCF[3] (see SM 1 for detailed information). To prevent against increasing Type I error due to multiple comparisons of the dependent variables within each task, we opted to use the Holm-Bonferroni correction; all of the *p* values reported already consider such correction. We also used Pearson correlations to explore the relation between performance and age. Mixed analyses of variance (ANOVAs) were conducted on all dependent variables to explore the effect of sex on performance and on the effect of the environment.

Results

Go/No-Go

When responding to this task in the high-load visual surrounding environment, children produced a significantly lower percentage of hits as compared to the low-load environment, $t(63) = -4.010$, $p = .003$, $d = .397$. No significant differences were obtained

[3] The original datasets will be provided upon request to the corresponding author.

in the percentage of false alarms or in the reaction times (*ps* > .05). The descriptive values are presented in Table 1.

Choice Reaction Time

Overall, children performed better when they responded to this task in the low-load visual surrounding environment than when they responded in the high-load environment. This pattern of results was obtained in two of the three variables of this task (see Table 1). Specifically, participants had a higher percentage of correct responses, $t(63) = -2.616$, $p = .033$, $d = .318$, and also faster reaction times for correct responses, $t(63) = 2.366$, $p = .042$, $d = .275$, in the low-load visual surrounding environment than in the high-load environment. No significant differences were obtained for the percentage of errors ($p = .108$).

Corsi Block-Tapping

Children obtained a higher Corsi span in the low-load visual surrounding environment compared to the high-load environment, $t(63) = -2.732$, $p = .008$, $d = .337$ (see Table 1 for the descriptive values).

Rey Complex Figure

We were most interested on the performance from the memory task, the cognitive process of interest here. As the descriptive data in Table 1 denote, in immediate recall children performed significantly better in the low-load visual surrounding environment than in the high-load environment, $t(63) = -3.107$, $p = .006$, $d = .328$. No significant differences between the two conditions were obtained in copy performance suggesting that the differences obtained in immediate recall cannot be attributed to a priori differences ($p > .05$).

On an exploratory note, we investigated the potential influence of sex in the effect of the environment by conducting ANOVAs, considering the influence of the environment as a within-participant factor (high load vs. low load) and of sex as a between-participants factor (male vs. female) on all the dependent measures[4]. We

[4] Given these analyses were only exploratory, no a priori care was taken to ensure full counterbalancing in each sex. The counterbalancing of environment order (but not of task order) is, however, largely complete in each sex.

obtained no significant main effects of sex or interactions in all dependent measures (lowest p = .072 for the main effect of sex in reaction times to correct responses); a main effect of environment, however, was obtained for all variables (highest p = .020 for reaction times to correct responses). These results are in agreement with previous studies reporting that sex differences in childhood are minimal and appear in only a small number of cognitive tasks (Ardila, Rosselli, Matute, & Inozemtseva, 2011). We also explored the correlation between cognitive performance (obtained in the low-load visual surrounding environment) and age, predicting that performance would improve as children got older (e.g., more correct responses and shorter response times); all correlations were significant in the predicted directions, with the exceptions of the correlations between age and false alarms and between age and errors that were not statistically significant (see Table 2).

Table 1

Descriptive data for the two attention tasks and two memory tasks.

	High-load environment	**Low-load environment**
Go/no-go		
Hits (%)**	**84.90 (13.93)**	**90.12 (12.32)**
False alarms (%)	29.65 (16.67)	29.95 (17.96)
Reaction times (ms)	378.70 (36.88)	377.55 (46.48)
Choice reaction time		
Correct responses (%)*	**73.10 (17.05)**	**78.27 (15.45)**
Errors (%)	10.94 (5.95)	12.51 (9.12)
Reaction times (ms)*	**378.45 (48.81)**	**363.82 (57.17)**
Corsi block-tapping		
Corsi span**	**4.39 (.95)**	**4.70 (.89)**
Rey Complex Figure		
Copy (points)[#]	31.74 (4.42)	32.13 (4.23)
Immediate recall (points)**	**21.75 (6.13)**	**23.76 (6.14)**

Note: Mean values (and standard deviations) are presented for each variable by environmental condition. Statistically significant effects are in bold. *p < .05; **p < .01. [#]The administration of this task was a requirement to the immediate recall task and is not of particular interest to our goals.

Table 2

Pearson correlation coefficients between age and each variable of each cognitive task.

	Go/no-go			Choice reaction time			Corsi blocks	Rey Complex Figure	
	Hits	False Alarms	Reaction Times	Correct Resp.	Errors	Reaction Times	Span	Copy#	Immed. Recall
Age	.265*	-.087	-.431**	.392**	-.093	-.410**	.415**	.514**	.368**

Note: **p* < .05; ***p* < .01. #The administration of this task was a requirement to the immediate recall task and was not of particular interest to our goals.

Discussion

In this initial study, we experimentally manipulated the surrounding environment and investigated the effects of this manipulation on children's performance in two visuospatial attention tasks and two memory tasks. Even though the study of distraction has a relatively long history, studies have relied mostly on procedures where the main task and the distractors are presented on the same display (e.g., the computer screen; Gaspelin et al., 2015). The procedure adopted in this study introduced a more ecologically valid procedure that exposes the distractors in the surrounding environment, a situation that is more common in children's daily lives. Although some studies have addressed a similar question with different age groups (Fisher et al., 2014; Hanley et al., 2017; Mastroberardino & Vredeveldt, 2014; Stern-Ellran et al., 2016), they used different procedures and looked at more global measures (e.g., learning). The current study investigated cognitive processes known to underlie many other processes and also adopted a careful experimental procedure that has not always been implemented in these studies (e.g., counterbalancing of the environmental conditions and tasks).

Overall, our results revealed that children's cognitive performance was reduced in all of the four cognitive tasks when these were done in the high-load visual surrounding environment. Our findings are in line with previous studies in which children's learning, structured play, and memory performance presented a decrement when tasks occurred in a decorated/high-load condition compared with when they occurred in a non-decorated/low-load condition (Fisher et al., 2014; Hanley et al., 2017; Mastroberardino

& Vredeveldt, 2014; Stern-Ellran et al., 2016). A negative effect of the presence of distractors has also been obtained in studies where targets and distractors were presented on the computer screen (e.g., Gaspelin et al., 2015). Importantly, we used a more ecological approach that more closely resembles the conditions in which children need to operate in their daily lives while assessing processes that are crucial to learning and that are widely used in several contexts (e.g., Vuontela et al., 2013).

Our findings could be related to the fact that children's cognitive capacities are still under development, including executive functions responsible for the filtering of irrelevant information for a given task (Craik & Bialystok, 2006; Dixon et al., 2014). Similar to what happened with the older adults in the study by Rodrigues and Pandeirada (2015), we speculate that in the high-load condition children would face difficulties in managing the competing visual information provided by the two sources of stimulation: the stimuli from the tasks and the visual surrounding elements. Distractibility was also expected given that our surrounding environment contained information that differed substantially from the target information, posing higher demand on children's cognitive resources (Konstantinou et al., 2014). However, whereas in Rodrigues and Pandeirada's (2015) study the impairment observed in older adults was possibly due to the fact that their cognitive capacities were in decline, here the obtained decrease in performance was likely due to the still immature cognitive system of children (Craik & Bialystok, 2006).

We can speculate about the implications of these results to children's lives. The important role of the level of stimulation afforded by the external environment is recognized in formal models, as noted in the Introduction (Barrett et al., 2015), and merits much more research. Our results suggest that some of the typical settings one finds in learning environments (i.e., sensory-rich classrooms) could hamper children's learning gains rather than help. Because our child participants provided fewer hits, fewer correct responses, and longer reaction times to respond correctly (choice reaction time), and also obtained worse memory performance in the two memory tasks, when responding to tasks while surrounded by the high-load visual surrounding environment, we can ponder whether such difficulties can translate into the real contexts (e.g., classrooms). The results from Fisher et al. (2014), which revealed that children spent more time in off-task when in the decorated-classroom, seem to support this suggestion. Also, off-task behaviors or inattention by children have been widely documented in educational settings as some of the factors restraining learning gains (Godwin et al.,

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2016). Our findings are also of potential relevance in other areas. As revealed by Mastroberardino and Vredeveldt (2014), the presence of visual environmental stimuli can impair children's ability to report visual information about an eyewitness event, a result with clear direct implications to forensic psychology. However, more research is needed to explore whether different elements in the surrounding environment affect children's performance in differential ways; for example, in the academic context, the visual elements could be relevant (or not) to the content being taught, with their impact possibly changing as exposure time increases (e.g., habituation processes might occur).

Another applied context in which our results could have implications is the clinical settings; if the surrounding environment affects visuospatial cognitive performance (e.g., RCF, a task widely used in cognitive assessments), the evaluator might need to consider the characteristics of the environment in which the assessing is occurring in order to make a reliable evaluation. This is particularly relevant when dealing with clinical groups, as suggested by the increased effect of the environment in children with autism as compared to children without autism (Hanley et al., 2017).

Even though we speculate that the damaging effect of our high-load visual surrounding environment was due to some "distraction," more studies are needed to establish the validity of this paradigm and then debate its practical implications. For example, a combination of the procedure presented in our study along with objective behavioral measures (e.g., eye-tracking, video-recording) that could inform about the mechanisms that underlie our results should be implemented in future studies. Future studies should also consider the role individual differences play in distractibility differences such as working memory capacity (e.g., Sorqvist & Ronnberg, 2014). Furthermore, it would be relevant to consider internal distraction given that several studies have revealed, for instance, that individuals disposed to "mind wandering" are more susceptible to distraction by irrelevant stimuli (Forster & Lavie, 2014). Finally, a limitation of our study, as well as of the previous studies that explored the influence of distractors on performance, is the lack of an objective definition and assessment of "load" (Murphy & Greene, 2016), which should be considered in future studies.

In sum, this initial study introduces a novel paradigm to study the influence of distractors in children's cognitive performance and should be considered a starting point to many future studies. These will provide relevant information that will help us to design environments that afford a richer development in various areas.

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