Scientific Collaboration with Educators: Practical Insights from an in-Class Noise-Reduction Intervention

Jessica Massonnié[1], Philippe Frasseto[2], Denis Mareschal[1], and Natasha Z. Kirkham[1]

ABSTRACT— Moving the field of Mind, Brain, and Education forward requires researchers and educators to reframe the boundaries of their own discipline in order to create knowledge that is both scientifically based, and of practical relevance for education. We believe that this could be done by co-constructing research projects *from the start*. We present a case study of a noise-reduction intervention in elementary classrooms, in which teachers and researchers worked together from the onset of study design. We examine the processes behind: (1) selecting research questions and measures, (2) planning interventions, (3) receiving ethical approval and funding, (4) recruiting schools, and (5) collecting data. At each step, our study provides suggestions for future collaborative efforts, keeping in mind broader theoretical and methodological implications. We believe that our concrete examples and suggestions will be useful for beginning and confirmed researchers, as well as teachers aiming to know more about research projects.

The last three decades have seen the growth of *Mind, Brain, and Education* research, bringing together psychology, neuroscience, and education research in order to better understand learning processes (Brookman-Byrne & Thomas, 2018; Pasquinelli, 2011). This research has provided information about (1) how students engage with learning, as well as build and consolidate knowledge (Howard-Jones et al., 2018); (2) which learning techniques are more effective (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Roediger III & Pyc, 2012); and (3) how sleep, physical exercise, and stress reduction can benefit learning and well-being (Thomas, Ansari, & Knowland, 2019).

Several difficulties remain in order for this cross-disciplinary field to achieve its full potential. Despite the growing enthusiasm of both researchers and educators to collaborate in scientific research, recent reviews and reports have pointed at key areas of frustration (Brookman-Byrne & Commissar, 2019; Commissar & Brookman-Byrne, 2017; Hobbiss et al., 2019; Pickering & Howard-Jones, 2007). For example, field-specific vocabulary and methods (Della Chiesa, Christoph, & Hinton, 2009), as well as practical differences between the logistics of research projects and educational projects (time, ethics, funding; Ellefson, Baker & Gibson, 2019) can make collaboration complicated. In the first part of this paper, we will expand on these issues and propose conditions under which more fruitful collaborations can be developed. In the second part, we will describe a case study of a collaboration between a UK-based academic psychology lab and French primary schools, which was aimed at developing an effective intervention to reduce auditory noise in the classroom.

PART I: CURRENT CHALLENGES WHEN DEVELOPPING LAB-SCHOOL COLLABORATIONS

Field-Specific Vocabularies

Many academic fields employ specific vocabularies, in which different disciplines show clear preferences for particular term meanings (see Hyland & Tse, 2007 for a discussion). For example, the word "perseveration" has a dictionary

[1]Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London, UK
[2]Académie de Corse, UK

Address correspondence to Jessica Massonnié, Department of Psychology and Human Development, Institute of Education, University College London, 24 Woburn Square, London WC1H 0AA, UK; e-mail: j.massonnie@ucl.ac.uk,

definition related to "the continuation of something […] usually to an exceptional degree or beyond a desired point" (Perseveration, n.d.). The term "to persevere" can have positive connotations in formal learning settings, where a child continues to work hard on a difficult task—to persevere means "to persist in a state, enterprise, or undertaking in spite of counterinfluences, opposition, or discouragement" (Persevere, n.d.). However, in psychological research this same term tends to have negative implications, referring to situations in which a participant is continuing to display a behavior even after that behavior is no longer considered appropriate. (e.g., Munakata, Morton, & Yerys, 2003).

In addition, teachers tend to use the word "attention" to mean the capacity to stay focused on an activity (or the teacher) for a prolonged period of time. However, within the psychological sciences, this would be defined as "on-task behavior" or "sustained attention." But the concept of "attention" has other meanings. The attentional network theory, for example, differentiates three networks of attention (Rueda et al., 2004): alerting (*when* to pay attention), orienting (*what* to pay attention to), and executive control (how to select and organize information to achieve long-term goals). Thus, discrepancies in vocabulary can make it difficult for educators to find the relevant research evidence, for researchers to disseminate and translate their findings, and for both communities to find a common ground for discussing questions of mutual interest.

From Lab to Classroom: Differences in Methodologies

Beyond issues with field-specific vocabularies, results from scientific studies do not always lead to straightforward conclusions that are generalizable across different experimental settings. For example, a widely used test in psychology research is the Flanker task (Fan, McCandliss, Sommer, Raz, & Posner, 2002; Rueda et al., 2004), which measures participants' accuracy and reaction time in response to a central target stimulus on a screen (e.g., an arrow). The task measures aspects of attention and inhibitory control by adding cues or varying the characteristics of the distracting stimuli surrounding the target stimulus (e.g., participants have to indicate in which direction the central arrow is pointing, when it is surrounded by other arrows pointing in the same, or the opposite direction). The test is specific enough to study the different processes underlying different components of attention (e.g., alerting, orienting, and executive control, as defined above, see Rueda et al., 2004). However, participants are tested in standardized conditions, removed from their natural environments, which raises the question of whether laboratory tasks of attention necessarily correlate with broader measures of attention in everyday life (Eberhart & Baker, 2018; Ellefson, Baker, & Gibson, 2019; Toplak, West, & Stanovich, 2013). When reaching out to wider audiences, it is therefore important for researchers to explain which behavioral tests they use, in order to avoid undue generalizations. Researchers could help by providing accessible summary of their findings through direct communication with the general public (e.g., school workshops, public lectures) or the media (e.g., radio interviews, blog posts; Eagleman, 2013; Morein-Zamir & Sahakian, 2010).

This section has highlighted an important distinction between laboratory research and educational outcomes. Researchers can finely control variables in experimental paradigms, allowing for clean dependent measures that are reliable and valid. However, the classroom is not a controlled environment. Understanding learning processes in the lab does not necessarily translate into viable interventions in the classroom (Anderson, 2002; Schmuckler, 2001). So how do we create evidence-based scientific collaborations between laboratory research and the classroom?

Developing Interactions between Laboratory and Real-World Research

In a discussion of how to move laboratory-based paradigms into real-world environments, Matusz, Dikker, Huth, and Perrodin (2019) describe a three-part cyclical model of research, delineating the advantages and limitations of each (1) "classic" piecemeal laboratory research allowing maximal control over the environment (but little room for natural input); (2) naturalistic laboratory research, including controlled variability (e.g. systematically varying task format, relevance, or demand); and (3) naturalistic, real-world research involving multiple interacting factors that cannot all be controlled for. Navigating between these three types of research can be difficult for both researchers and educators, for a variety of reasons including, but not limited to, time and resources.

To facilitate the development of naturalistic, real-world research, some recent work has focused on the topic of raising teachers' awareness of research methods, through conference attendance, initial teacher training, or continuous professional development (Brookman-Byrne & Commissar, 2019; Kelleher & Whitman, 2018). A linear model is still often implied—scientific knowledge would emerge from the laboratory, before being tested and implemented in the classroom (Daniel, 2012). This might leave teachers in a situation where they are merely a gateway to experimental participants, rather than collaborators in the research. There is also a risk for researchers to be, or at least to appear prescriptive (Howard-Jones & Ioannou, 2018; Willingham, 2009), blurring boundaries between what constitutes scientific evidence and what is "good" or "desirable" for pupils. While keeping in mind the goals of each field, teachers' involvement would help to build more comprehensive, realistic, and impactful projects. Researchers could benefit from teachers' knowledge about the practical factors of learning in a classroom setting, and about the constraints they experience every day. Likewise, teachers could benefit from being exposed to new methods, which allow them to test the efficiency of pedagogical practices (Churches & McAleavy, 2015).

To make these collaborations happen, it is worth keeping in mind key factors favoring teachers' participation in research projects, such as time resources (Simmonds, 2014) and the involvement of multiple stakeholders within their school (Coldwell et al., 2017). These can be triggered by collaborative funding applications incorporating a budget for schools to free up teachers' time and/or buy relevant resources and materials (Commissar & Brookman-Byrne, 2017).

PART II: CLASSROOM NOISE-REDUCTION INTERVENTION: A TEACHER–RESEARCHER COLLABORATION

We turn now to presenting the case study of an international collaboration between a UK laboratory in psychological sciences, and a group of French primary schools, who co-constructed a research project focused on reducing classroom noise. We aim to provide some clues about how the aforementioned difficulties could be overcome to facilitate future collaborations. In addition, we wish to reflect on the challenges encountered to feed broader debates about Mind, Brain, and Education. Whereas several inspiring examples of collaborations have already been published (e.g. Glennon, Hinton, Callahan, & Fischer, 2013; Plummer et al., 2014), this project was unique because teachers and researchers worked together from the start to design the study, define its underlying ethical rules, and secure funding. As such, the project fits with recent recommendations that have been made to move the field of Mind, Brain, and Education forward (Brookman-Byrne & Commissar, 2019).

The main steps of the project are summarized in Figure 1. A linear timeframe has been depicted to keep the chronology in mind. However, as will be stressed throughout the paper, the research was not fully designed a priori, in the laboratory, before being applied in schools. Instead, it was built using an iterative process.

The Origin of the Current Research

The current project emerged from a meeting organized by a French organization whose aim was to familiarize teachers with research methods so that they can develop scientific projects with their pupils (Les Savanturiers—L'école de la recherche, 2018). Attendance at this event was not part of any teacher training or continuous professional development plan. The first author of this paper, an early-career researcher working on classroom noise, was sharing her experience of research within the field of psychology. The second author was attending as an elementary school teacher looking to develop a project on attention – a skill that, for him, is fundamental in school. During informal discussions, the teacher suggested that classroom attention would benefit from less noise in the school setting. A suggestion was made that involving children in educational interventions could be advantageous. These interventions could consist of installing visual panels that display noise levels, and in mindfulness practice. The teacher's idea was based on his own collaborations, on the resources available in his teaching area, and on the assumption that noise was bad for learning and well-being.

This idea that noise is bad for learning is very intuitive, but systematic research suggests that it is not always the case. For example, although noise can cause communication difficulties and impair children's performance when they are engaged in attention and memory tasks (for reviews, see Klatte, Bergström, & Lachmann, 2013; Shield & Dockrell, 2003), it does not systematically have a negative impact on reading and mathematics performance, when children are engaged in solo work (Dockrell & Shield, 2006; Ljung, Sorqvist, & Hygge, 2009). Furthermore, noise might be less detrimental during collaborative activities, where one of the main purposes is to facilitate discussions. In other words, whether noise is negative for learning must be understood in light of the specific educational context.

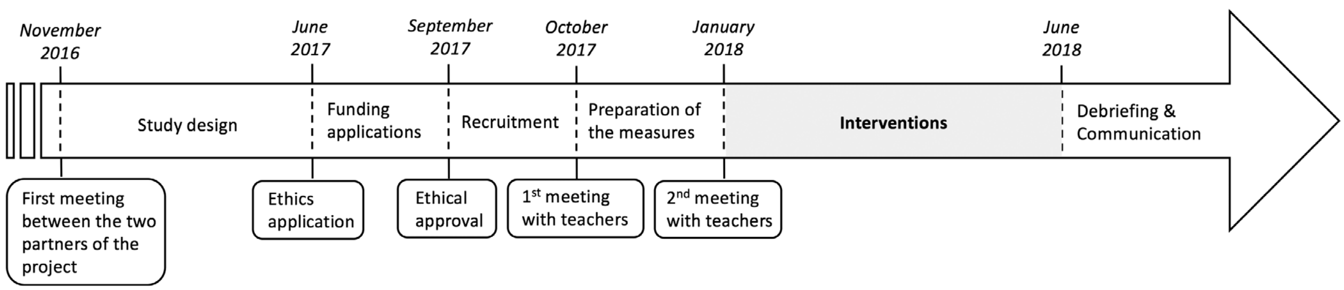

Fig. 1. Timeframe of the research project.

Research Questions

Our main goals were to understand (1) how classroom noise can be reduced in the classroom and (2) whether that would be associated with improved attention and/or reduced feelings of interference and annoyance from noise.

Designing the Interventions

In order to reduce noise, we first focused on participatory interventions (e.g., getting the pupils themselves involved), as suggested by the teacher. The current literature mainly focuses on physical solutions (e.g., sound absorbent panels; Berg, Blair, & Benson, 1996; Maxwell & Evans, 2000), which do not discriminate between types of noise to regulate, nor when to regulate it (Woolner & Hall, 2010). In classrooms which are only moderately exposed to external noise (e.g., transportation noise), classroom noise mostly comes from the pupils (Enmarker & Boman, 2004; Shield & Dockrell, 2004). Therefore, raising their awareness could be an efficient way to modulate noise levels.

One way to make pupils aware of the noise in the classroom is through the use of visual display monitors to show and control noise levels. These monitors are recommended on educational and commercial websites (e.g., see the apps Bouncyballs or Too Noisy). They provide a signal (e.g., color codes) indicating when noise levels are above a certain threshold. In the current project, we decided to combine an educational program with a system of visual aid. Indeed, both dimensions seem important to engage the students in reducing noise levels in the long term (Daniel, 2007). Instruction about noise on its own (without tools to regulate it) might actually raise noise annoyance by a greater awareness of it (Bulunuz, 2014). Conversely, visual tools implemented without further instructions might not be sufficient to induce significant and long-term changes. A 6-day intervention with the commercial tool SoundEar® reduced noise levels of 1.4 dB on average in elementary classrooms (Van Tonder, Woite, Strydom, Mahomed, & Swanepoel, 2015). It is estimated that a 6- to 10-dB increase has to happen for the noise to be *subjectively perceived* as twice as loud (Nathanson & Berg, 2019).

When we started to design the study, our teacher partner suggested to install visual panels in the schools' communal areas (e.g., corridors, canteen); however, after discussion we agreed to place them in classrooms (where learning takes place). This also helped to compare this intervention with mindfulness practice.

Our review of the literature, inspired by the teacher's connections with mindfulness practitioners, suggested that mindful practice might improve attention and behavioral control, while creating a heightened awareness of classroom noise, and concurrently the motivation to reduce it.

Mindfulness practice highlights the need to train one's attention, and to adopt an open and accepting orientation toward one's experience and environment (Kabat-Zinn, 2003; Rempel, 2012). It includes elements of yoga, which itself involves physical postures, breathing exercises, relaxation, and meditation (Ferreira-Vorkapic et al., 2015). There is a growing literature about school-based yoga and mindfulness interventions revealing a positive impact on children's capacity to regulate their attention, behavior, mood, and emotions (for reviews, see Felver, Celis-de Hoyos, Tezanos, & Singh, 2016; Ferreira-Vorkapic et al., 2015; Rempel, 2012; Zenner, Herrnleben-Kurz, & Walach, 2014). Norlander, Moås, and Archer (2005) noted a reduction of classroom noise levels (from 63.24 to 50.50 dB) following 4 weeks of daily relaxation exercises. Children had better levels of concentration (as indicated by their teacher). Interestingly their stress level and perception of noise did not change. This could be because they did not consider their classrooms very noisy to start with, as indicated by the baseline data. In the case of noisier classrooms, the nonjudgmental aspect of mindfulness, on top of an actual reduction in noise levels, could protect children from feelings of annoyance.

There is a crucial lack of randomized control trials assessing the long-term effects of school-based mindfulness practice, and comparing it with other active interventions, using behavioral and self-report measures (Chung, 2018; Felver et al., 2016). The goal of the current study was to compare three groups of children, receiving either a mindfulness training, a sound awareness intervention (visual displays), or waiting to receive an intervention at the end of the year (control group).

The interventions were collaboratively designed. The research team identified the parameters (e.g., dosage and duration) that had to be considered to compare results with the existing literature. Our teacher partner considered the practicalities of classroom environments. Sound and mindfulness experts helped to create materials and pedagogical sessions.

Interventions included a short-term and a long-term component. The time frame is depicted in Figure 2.

The short-term component consisted of four 1-h workshops, led by an expert in each area (mindfulness or sound awareness). This length was chosen to enable the comparison with the 1- to 3-h noise seminars implemented by Bulunuz (2014), and with mindfulness sessions carried out by external facilitators (Felver et al., 2016). The sound awareness workshops included hands-on activities to discuss the concepts of sound, noise (defined as an unwanted or unpleasant sound; Erickson & Newman, 2017; Kanakri, Shepley, Varni, & Tassinary, 2017), and music. Children were invited to pay attention to the sounds that they could hear inside and outside the classroom, discussing their impact on attention, memory, well-being, and on the auditory system. The visual

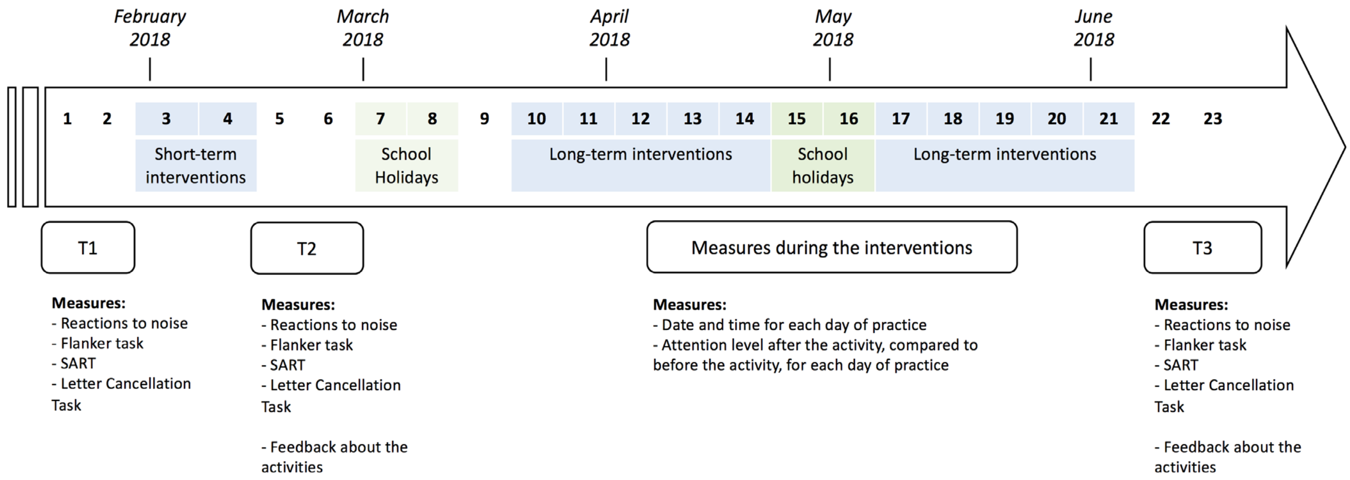

Fig. 2. Timeframe of the interventions.

panels to be used in the long-term intervention were presented. The mindfulness workshops included a combination of body postures, breathing exercises, meditation, and sensory awareness activities. Pictures are provided in Figure 3.

The long-term component of the interventions was led by the classroom teachers, upon suggestion by our teacher collaborator. Directly involving teachers allowed to empower them to change their classroom environment, while taking each school's context and needs into account (Coe, 2017; Kelleher & Whitman, 2018). On the research side, teachers' involvement allowed to test the generalizability of the interventions across contexts. Teachers were provided with materials (created by the experts and the research team) that they could use with their pupils on a daily basis, for 5–10 min, over a period of 10 weeks. This duration corresponds to the minimum time that has been used in the mindfulness literature, and to the duration of the relaxation sessions in Norlander et al. (2005)—although they implemented the activities twice a day, not once. Long-term assessments were necessary for the sound awareness group because students and teachers might need time to develop new attitudes (Bulunuz, 2014; Van Tonder et al., 2015).

The long-term component of the sound awareness interventions introduced the visual panels, which presented different colors, depending on whether noise levels were low (green), moderate (orange), or high (red). They went black when the class was calm for more than few seconds, with no sound standing out from the context. To facilitate the use of the panels, children were invited to play the "silence game" every day, reducing noise levels so that the panels became black, and holding this silence for as long as possible (up to 3 min). Children also had to estimate weekly the amount of noise (in decibels) corresponding to a given behavior (e.g., everyone talking at the same time), before checking the value with a handheld sound level meter. For the mindfulness intervention, teachers played, every day, one of four sounds files created by our mindfulness expert.

Ensuring fidelity for the long-term intervention was challenging (Dusenbury, Brannigan, Falco, & Hansen, 2003), and the balance between flexibility and fidelity was discussed with our teacher partner. It was decided that participating teachers should be given some flexibility about when to do the activities in order to adapt to the rest of the school life. The recommended time of practice was after the lunch break (teachers in our sample considered this to be one of the noisiest moments of the day), but it could be another moment if needed. In the mindfulness group, teachers could decide which audio file to use on a given day, provided that they used all four during the week. Some variation in the implementation of the activities was therefore expected. Children were given individual booklets to fill after each activity. This allowed us to know when, and at which frequency they were practicing, without putting pressure on the teachers to report themselves what happened every day.

Measures

In their individual booklets, children indicated the date and time for each day of practice. They were asked whether they felt "way less attentive," "a little less attentive," "similar," "a bit more attentive," or "way more attentive" after the activity, compared with when they arrived in the classroom before the activity.

At the end of the short-term and long-term interventions, children were asked whether they liked the activities, found them useful, or difficult (answering "not at all," "not really," "a bit," or "really").

Children's subjective reactions to noise were measured before the interventions (T1), after the short-term part (T2), and after the long-term part (T3). Three

(a) (b) (c) (d)

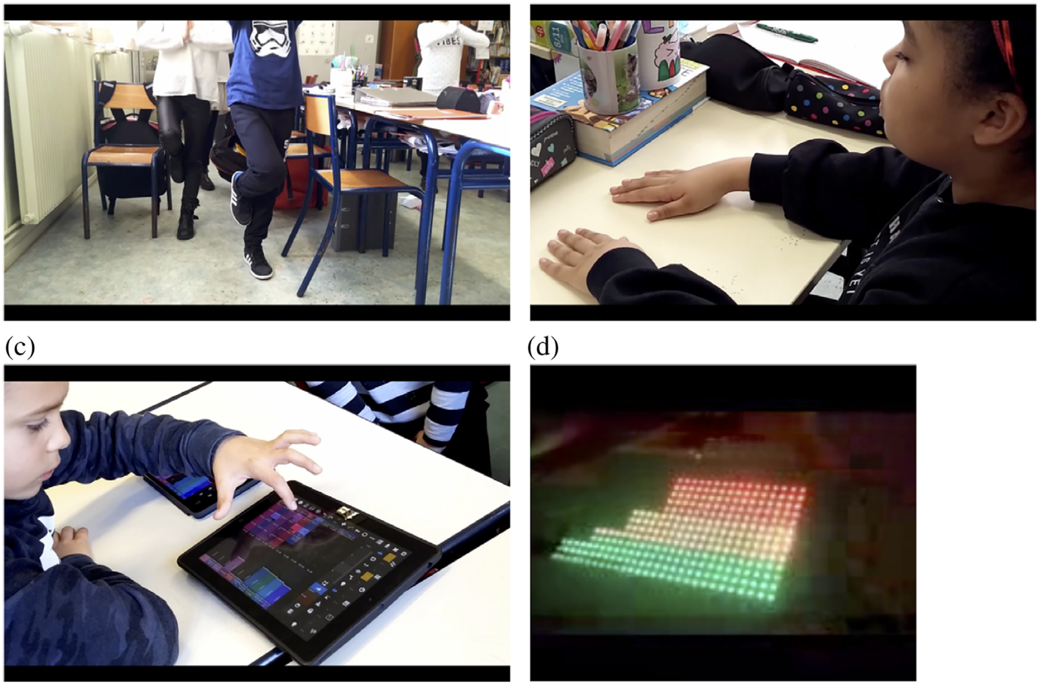

Fig. 3. The mindfulness short-term workshops included body postures (a) and meditation (b); the sound awareness workshops included the manipulation of sounds (c) and the presentation of the visual panels (d).

dimensions (extracted through factorial analyses) were evaluated: attention capture (i.e., children notice noise in the classroom), noise interference (i.e., noise distracts children from their ongoing task), and noise annoyance. Each dimension included a set of questions referring to four classroom activities: listening to the teacher or a classmate during a lesson, listening to the teacher or a classmate during a private conversation, solo work, and group work.

Three behavioral measures of attention were included at T1, T2, and T3. First, a computerized Flanker task (Anwyl-Irvine, Massonnié, Flitton, Kirkham, & Evershed, 2020, adapted from Rueda et al., 2004) measured children's capacity to resist interference from distractors. Children saw a row of five fish and indicated the direction that the middle fish was pointing to when it was surrounded by fish pointing in the same direction (congruent trials) or in the opposite direction (incongruent trials). The longer children take to react to the correct answer to incongruent trials in comparison to congruent trials, the lower their attentional control. Improvements on this task have been reported following mindfulness practice among children (Biegel & Brown, 2010) and adults (Tang et al., 2007). Second, in the Sustained Attention to Response Task (SART), children had to press the space bar when they saw a picture of a mole (76% of the trials), but not when they saw an eggplant. The variability in their reaction time (standard deviation of their reaction time distribution) was calculated (McVay & Kane, 2012), with higher variability indicating lower sustained attention. Third, to complement these two computerized tests, a paper-and-pencil Letter Cancellation task was included. Participants crossed out all the "T" and "G" on a A4 paper sheet. The total score (Geldmacher, 1996) combined speed and accuracy: (number of correct responses/number of targets) × (number of correct responses/total time). Higher scores indicate better performance. According to our teacher partner, this measure is more representative of what teachers conceive as "paying attention to an exercise" in the classroom, compared to computer-based tasks focused on short reaction times.

Noise levels were measured with sound level meters placed on the front wall of each class. Samples of 1 min were continuously collected and sent over the Internet to an anonymized database.

Overall, the choice of measures was guided by previous research (to make comparisons with other studies possible), and by teachers' suggestions (to ensure that the analyses would provide useful conclusions for them). Behavioral tests were mostly designed by the research team, whereas questionnaires and children's booklets were coconstructed with our teacher partner. He helped to phrase questions that would be easily understandable by children, and that would have practical values for educators.

The study included additional measures addressing different questions. In the interest of focus and succinctness, these will not be discussed here.

Hypotheses

We predicted that both the mindfulness and sound awareness interventions would reduce classroom noise, in comparison to the wait-list control condition. These effects should be more pronounced after the long-term intervention, because it gives both children and teachers time to integrate and incorporate the new activities in their daily life. Moreover, we expected mindfulness practice to lead to better attention, and reactions to noise (Felver et al., 2016; Zenner et al., 2014), when compared to the wait-list control condition. The novel aspect of the sound awareness workshops might be attractive to children, but it was unclear whether they would have a positive effect on children's attention and reactions to noise (Bulunuz, 2014).

Ethics Application

Ethical approval was needed to recruit schools for participation (see guidelines from the British Psychological Society, 2014, the American Educational Research Association, 2011, and the Declaration of Helsinki). Procedures can take a long time, and this was especially true in our case because the project was international. An initial application was made to the University Ethics Committee, detailing the study design, measures, recruitment process, respect of participants, and data management. It included the information sheets communicated to schools, parents, and children, as well as authorizations from the regional inspector who was overseeing schools in our geographical area of interest. Communication went back and forth several times to ensure that French and British parties agreed on key elements (e.g., data anonymity, consent procedure). The interventions were integrated in the school curriculum and all the children took part. Individual data were collected following signed consent from the parents and verbal consent from the children.

Funding Application

While the ethical application was being processed, we worked on securing funding. Although resources were available from the researcher's affiliation, additional funders were contacted to hire the experts delivering the short-term interventions and to buy the sound level meters and visual panels. The experts and sound engineer we suggested were working in the same local area and were known by the French academies we approached for funding. We believed this helped funders to better get a sense of the project and to give their approval, knowing that the resources would benefit the local community.

Recruitment and Meetings with Schools

The recruitment process was different to what we experienced before (e.g., cold calling schools). Our teacher partner convinced his local inspector about the importance of the project. Via email, this inspector contacted the schools under his jurisdiction, forwarding a document summarizing the key elements of the project (short review of the literature, description of the measures and interventions, targeted population—children in their last 2 years of elementary school). The research hypotheses were not mentioned to avoid biases (e.g., teachers behaving differently if they expect a certain outcome). We received positive answers from six teachers, whose classes contained 126 pupils. Individual data were collected for 113 pupils.

The team was gathered in a common meeting, in October 2017. We took time to discuss teachers' sensitivity to classroom noise. Choosing to be involved in the project indicated a specific interest in the topic, and understanding teachers' expectations was a useful starting point to present the protocol. The main research questions were summarized, and measures were explained both theoretically (which construct were assessed) and concretely (which activities would be presented to children). Care was taken to highlight ethical rules, especially the fact that data would remain anonymous and would not be shared outside of the research team. Teachers were asked to present the research project to their pupils in the same way, to avoid biases. Children would be aware that we would investigate their perception of the classroom environment, but the relationships between the different type of measures (e.g., noise levels and attention) was not outlined. To avoid biasing the baseline measures of noise levels, teachers were asked not to warn, or ask children to make less noise before the interventions.

A second meeting was organized in January 2018, at the very start of data collection. Teachers were informed about their assignment to each condition (mindfulness, sound awareness, wait-list). This assignment was pseudorandom, to balance children's age across groups and to avoid school effects. In fact, two of the schools provided two classes each. These were assigned to different conditions, to avoid confounding the effects of school and condition. This procedure still raised the risk of diffusion effects, with children from different intervention groups influencing each other. To minimize this, we asked teachers not to share their materials with each other until the study was finished. We explained clearly why we needed two "waiting-list control" classes with delayed interventions (e.g., to have a measure of children's "normal" development during the year), in order for teachers not to feel neglected.

Teachers' attendance at the two preparatory meetings was officially recognized as part of their continuous professional development. Furthermore, the interventions fit with the French school curriculum, allowing teachers and pupils to work on core skills and elements of knowledge (e.g., science and technology, discussing feelings and emotions). Representatives from the French academies came to the meetings, highlighting the importance of following the research protocol. We believe that this greatly facilitated teachers' involvement in the project, by providing recognition and time resources (Coldwell et al., 2017; Simmonds, 2014). Nonetheless, it was important to plan data collection in a way that would be as undisruptive as possible.

Data Collection

Data collection took a maximum of 3 days per class. Behavioral tests of attention were carried out in individual sessions lasting 15 min maximum. This short duration prevented children from missing a lot of instructional time and helped adapting to unexpected events (e.g., it was easier to pause data collection if children needed to go to a school assembly, or to a specific lesson). Children's reactions to noise and feedback about the interventions were collected via questionnaires filled during collective sessions in class, under the supervision of the teacher. For data collection to run smoothly, a great deal of anticipation was needed. Teachers were asked about their schedule and potential periods of unavailability. The lists of pupils were printed and brought on site. The researcher provided all the necessary material for testing (e.g., computer, photocopies). Because behavioral tests were run online, a portable Wi-Fi router was used when the school's Wi-Fi was unstable. We highly recommend Plummer et al. (2014)'s article for organizational tips before, during and after data collection.

RESULTS

As expected, teachers varied in the way they implemented the long-term interventions. Within each intervention group, one class practiced more than the other (13 *vs* 33 days in the sound awareness group, 18 *vs* 29 days in the mindfulness group). Within each class, children practiced more or less because of occasional absences. However, in line with our recommendations, the activities were mostly carried out after the lunch break, and occasionally after the morning or afternoon breaks.

Despite these differences in implementation, there were very little differences between classes from the same intervention group (see Tables 1 and 2) when analyzing children's feedback (e.g., whether they liked the activities, found them useful, or difficult). The only significant difference was within the sound awareness group, with one class reporting more enthusiasm for the short-term intervention than the other ($\chi^2 = 8.09$, $p = .018$).

When comparing the two intervention groups, children did not differ in the extent to which they liked the activities ($\chi^2_{SHORT}(1) = .45$, $p = .80$; $\chi^2_{LONG}(1) = 3.82$, $p = .28$), found them useful ($\chi^2_{SHORT}(1) = .88$, $p = .83$; $\chi^2_{LONG}(1) = 4.52$, $p = .21$) or difficult ($\chi^2_{SHORT}(1) = 2.75$, $p = .43$; $\chi^2_{LONG}(1) = 1.08$, $p = .58$). Collapsing answers across all groups, 95.16% of the children liked the short-term interventions, 82.26% found them useful and 81.97% not difficult – numbers were 80.65%, 69.35%, and 90.16% respectively for the long-term intervention. Overall, participants were responsive, and the level of difficulty of the interventions was adapted.

At pretest, a Welch test[1] indicated significant differences in noise levels between the three groups ($F(2, 997) = 12.54$, $p < .000$). Games-Howell post hoc comparisons indicated that baseline noise levels in the control group ($M = 48.04$, $SD = 6.85$) were lower than in the mindfulness group ($M = 51.62$; $SD = 7.25$; $p < .001$), and in the sound awareness group ($M = 50.23$; $SD = 9.76$; $p = .004$). The difference between the mindfulness group and the sound awareness group was close to significance ($p = .057$).

Table 1
Children's Feedback about the Mindfulness Interventions, for the Two Participating Classes

	Mindfulness 1				*Mindfulness 2*				
	Not at all	*Not really*	*A bit*	*Really*	*Not at all*	*Not really*	*A bit*	*Really*	χ^2
Short term									
Did you …									
… like the activities?	0	1	2	13	0	1	7	10	3.06
… find them difficult?	7	6	2	1	8	5	4	0	1.80
… find them useful?	0	2	5	9	1	3	7	7	1.67
Long term									
Did you …									
… like the activities?	0	2	5	9	3	4	4	7	3.92
… find them difficult?	11	2	3	0	11	5	1	0	2.26
… find them useful?	2	5	2	7	3	4	7	4	3.80

Note. The class Mindfulness 1 practiced for 29 days, and the class Mindfulness 2 practiced for 18 days.

Table 2
Children's Feedback about the Sound Awareness Interventions, for the Two Participating Classes

	Sound 1				*Sound 2*				
	Not at all	*Not really*	*A bit*	*Really*	*Not at all*	*Not really*	*A bit*	*Really*	χ^2
Short term									
Did you …									
… like the activities?	0	0	0	13	0	1	6	8	8.09*
… find them difficult?	10	1	2	0	8	5	2	0	2.76
… find them useful?	1	0	5	7	1	3	6	5	3.30
Long term									
Did you …									
… like the activities?	0	2	4	7	0	1	3	11	1.23
… find them difficult?	11	2	0	0	11	2	2	0	1.87
… find them useful?	1	1	6	5	1	2	7	5	0.27

Note. The class Sound 1 practiced for 13 days, and the class Sound 2 practiced for 33 days.
* $p < .05$.

Table 3
Regression Analyses Testing the Effect of Intervention Group, Controlling for Age and Baseline Performance

	Short-term intervention			*Long-term intervention*		
	Mindfulness vs *control*	*Sound* vs *control*	*Sound* vs *Mindfulness*	*Mindfulness* vs *control*	*Sound* vs *control*	*Sound* vs *mindfulness*
Attentional skills						
Flanker task	.11 (.380)	−.01 (.913)	−.11 (.240)	−.15 (.170)	−.16 (.174)	−.02 (.841)
LCT	.08 (.313)	.15 (.099)	.07 (.422)	−.11 (.163)	.04 (.626)	.15 (.055)
SART	−.06 (.576)	.05 (.687)	.11 (.273)	.06 (.594)	.13 (.280)	.07 (.449)
Reactions to noise						
Att. Capture	.03 (.743)	−.02 (.844)	−.05 (.548)	.14 (.180)	−.05 (.619)	−.19 (.084)
Interference	−.08 (.460)	−.17 (.126)	−.09 (.411)	.12 (.286)	**−.23 (.027)**	**−.35 (.001)**
Annoyance	−.05 (.650)	−.16 (.158)	−.12 (.146)	.16 (.142)	−.10 (.409)	**−.25 (.024)**

Note. The table reports *ß* coefficients; *p-values* are in brackets. Significant comparisons are in bold. LCT = letter cancellation task; SART = sustained attention to response task.

Two repeated measures ANOVAs tested whether the change of noise levels from T1 to T2, and T1 to T3, differed between the three intervention groups. The first model, comparing T1 to T2, indicated a main effect of Time ($F(1, 997) = 21.72$, $p < .001$), but no significant interaction between Time and Intervention Group ($F(2, 997) = 0.07$, $p = .934$). In other words, noise levels decreased in each group between T1 and T2 (from 48.04 to 46.42 dB in the control group; from 51.62 to 49.75 dB in the mindfulness group; and from 50.23 to 48.23 dB in the sound awareness group).

The second model, comparing T1 to T3, showed a main effect of Time ($F(1, 997) = 136.13$, $p < .001$), and a significant interaction between Time and Condition ($F(2, 997) = 19.45$, $p < .001$). Games-Howell post hoc comparisons indicated that differences between the three groups were all significant at the .001 level. Follow-up paired t-test indicated a decrease in noise levels of 6.55 dB in the control group ($t(199) = 8.47$, $p < .001$), of 6.42 dB in the sound awareness group ($t(399) = 9.03$, $p < .001$), and of 1.48 dB in the mindfulness group ($t(399) = 2.68$, $p = .008$). Because an increase of 6- to 10-dB has to happen for the noise to be subjectively perceived as twice as loud (Nathanson & Berg, 2019), the reduction in noise levels occurring in the sound awareness and control groups is more likely to impact on pupils' and teachers' well-being. It should be noted that data from only one control class could be analyzed. Measures taken from the sound level meters were directly sent to an online database, and constant interruptions in the Internet connection of the second control class considerably reduced the number of samples available.

Children's reactions to noise and attentional skills were analyzed by regression analyses, each posttest value being regressed on the baseline value, age and intervention group (see Table 3).

Children from the sound awareness group reported lower noise interference after the long-term intervention ($M_{T3} = 1.88$, $SD_{T3} = .68$), compared with the baseline data ($M_{T1} = 2.18$, $SD_{T1} = .86$), differing from both the control group ($ß = -.23$; $p = .027$; for which ratings were pretty

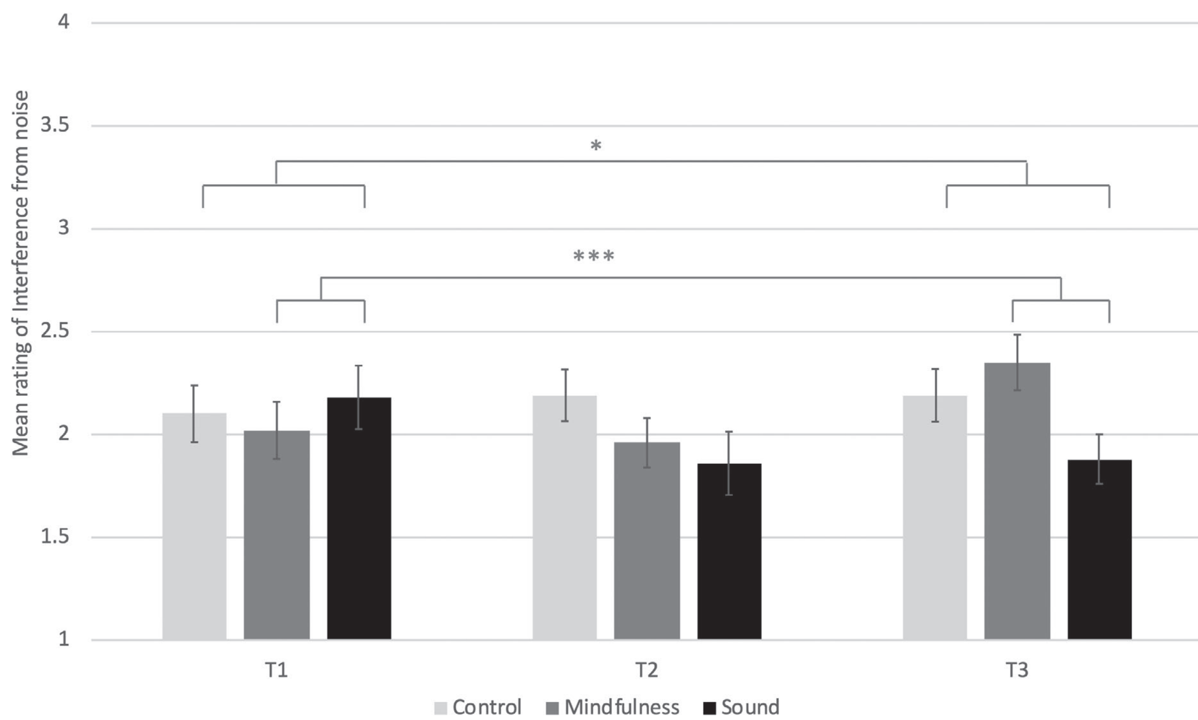

Fig. 4. Mean self-report of interference from noise at baseline (T1), after the short-term intervention (T2), and after the long-term intervention (T3), for each intervention group. Error bars represent standard errors. * $p < .05$; *** $p < .001$.

stable; $M_{T1} = 2.10$, $SD_{T1} = .77$, $M_{T3} = 2.19$, $SD_{T3} = .75$, and the mindfulness group ($ß = -.35$; $p = .001$; for which ratings increased; $M_{T1} = 2.02$, $SD_{T1} = .83$, $M_{T3} = 2.35$, $SD_{T3} = .79$). Figure 4 illustrates these results. Children in the sound awareness group also reported lower noise annoyance after the long-term intervention ($M_{T3} = 1.76$, $SD_{T3} = .70$), compared to the baseline data ($M_{T1} = 2.03$, $SD_{T1} = .76$), differing from the mindfulness group ($ß = -.25$; $p = .024$), for which annoyance ratings slightly increased ($M_{T1} = 2.18$, $SD_{T1} = .77$, $M_{T3} = 2.28$, $SD_{T3} = .84$), but not differing from the control group ($ß = -.10$; $p = .409$).

We did not find any intervention effect on the behavioral measures of attention (see Table 3).

Individual computerized tests were carried out outside of class to avoid disrupting lessons, with the assumption that the tests provided a screenshot of participants' attention skills at a given point in time (this kind of assumption is not uncommon in studies using a pre- posttest design). However, data from the individual booklets revealed great variability in children's changes in attention after their daily practice, in both the mindfulness and sound awareness group. Some children were quite constant in their answers, whereas other children reported greater fluctuations depending on the day of practice. The self-report data from the individual booklet are not directly comparable to the behavioral measures based on short reaction times, but we believe that measures of attentional skills *in context* (e.g., in the classroom) are more promising and naturalistic than one-shot assessments.

Communication

Results took months to be processed. Yet, we wanted to provide the children and teachers with immediate feedback about the study, to avoid a loss of interest. A debriefing session was therefore organized in every classroom after the last day of data collection, including a 1-hour workshop about attention. Pupils could ask any question they had on the project. Results from the baseline data (about interindividual differences in children's reactions to noise) were communicated. Children's feedback about the interventions was shared with the teachers and the experts themselves.

CONCLUSION

This paper presented the co-construction of a scientific project by researchers and teachers, aimed at designing efficient noise-reduction interventions in class. Overall, the sound awareness interventions seem the most promising to help children cope with classroom noise, because they are associated with a reduction in noise levels, and in negative reactions to noise. Beyond the results of the study, we believe it is essential to facilitate direct partnerships between researchers and teachers, to develop projects over longer periods of time. Indeed, it is only when both parties are engaged in each step of the project that they can fully reflect on their vocabulary, methods, and practice. Pairing systems could be facilitated as part of teachers' and researchers' initial training. They can also be established through external organizations (as was the case in the current study, through Les Savanturiers), or directly online (Hobbiss et al., 2019). Ultimately, fruitful partnership would reduce the need to translate knowledge from one field to another a posteriori, because it would have been co-constructed from the start (see recommendations in Box 1).

Box 1. Key recommendations for researchers willing to carry out projects in schools.

Study design:

- Stay flexible, allowing teachers to participate in the study design and to give their opinion about the measures.
- Try to find a compromise between the requirements for the project to be scientifically valid and its practical value for educators.

School interventions:

- Consider the potential biases that can emerge if researchers, educators, and/or experts carry out the interventions.
- Keep the broad scope of the study in mind (Do these interventions aim to be generalized?)
- Measure fidelity and adhesion (observations, and teachers' and pupils' self-reports).

Ethics and funding:

- Anticipate the ethical procedures several months before the start of the project.
- Involve teachers in funding applications to make a strong case for the impact of the project.
- Working with local partners can enhance perceived benefits for the community.

Recruitment:

- Involve multiple people, at different levels of the hierarchy: education inspectors, headteachers, teachers, parents, children …
- Inquire about schools' motivations and personal reasons to participate in the project.

Data collection:

- Plan short testing sessions and try to disrupt teaching activities as little as possible.
- Stay flexible on the date and time of visits.
- Provide all the material needed to run the experiment.
- If possible, visit the school before data collection and anticipate potential difficulties (lack of a spare room, presence of distractors, etc.)

Communication:

- Provide different levels of communication to pupils, parents, teachers, policy makers and fellow researchers.
- Try to identify preliminary conclusions that would be useful for educators without compromising scientific validity if formal publications are still pending.

Acknowledgments—This work was funded by the Economic and Social Research Council (grant reference: 13115739), by the Centre for Brain and Cognitive Development of Birkbeck University, and by the Rectorat de Corse (Cellule Santé et Sécurité). We would like to thank Antoine Chélélékian, Julien Pons and Claude Mendivé, for their continuous support and confidence in the project. Their help in the funding and recruitment processes were invaluable. We would like to thank Marie Frasseto (Association Pace Salute) and Tommy Lawson (Association Zone Libre) for designing and running fascinating school interventions. Finally, we thank Kathryn Bates for her constructive feedback on an early draft of the paper.

DISCLOSURE STATEMENT

The authors declare that there is no conflict of interest.

NOTE

1 A Welch test was performed instead of an ANOVA because the assumption of homogeneity of variance between groups was violated, the Levene's test being significant ($F(2, 997) = 34.89, p < .001$)

REFERENCES

American Educational Research Association. (2011). *Code of ethics*. Retrieved from http://www.aera.net/About-AERA/AERA-Rules-Policies/Professional-Ethics

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, *8*(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Anwyl-Irvine, A., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior Research Methods*, *52*(1), 388–407. https://doi.org/10.3758/s13428-019-01237-x

Berg, F. S., Blair, J. C., & Benson, P. V. (1996). Classroom acoustics: The problem, impact, and solution. *Language, Speech, and Hearing Services in Schools*, *27*(1), 16–20.

Biegel, G., & Brown, K. W. (2010). Assessing the efficacy of an adapted in-class mindfulness-based training program for school-age children: A pilot study. *White Paper*. Retrieved from http://www.mindfulschools.org/pdf/Mindful%20Schools%20Pilot%20Study%20Whitepaper.pdf

British Psychological Society. (2014). *Code of human research ethics*. Retrieved from https://www.bps.org.uk/sites/bps.org.uk/files/Policy%20-%20Files/BPS%20Code%20of%20Human%20Research%20Ethics.pdf

Brookman-Byrne, A., & Thomas, M. S. C. (2018). Neuroscience, psychology and education: Emerging links. *Impact*, *2*, 5–8. Retrieved from: https://impact.chartered.college/article/brookman-byrne-neuroscience-psychology-education/

Brookman-Byrne, A., & Commissar, L. (2019). Future avenues for educational neuroscience from the perspective of EARLI SIG 22 conference attendees. *Mind, Brain, and Education*, *13*(3), 176–183. https://doi.org/10.1111/mbe.12211

Bulunuz, N. (2014). Noise pollution in Turkish elementary schools: Evaluation of noise pollution awareness and sensitivity training. *International Journal of Environmental and Science Education*, *9*(2), 215–234. https://doi.org/10.12973/ijese.2014.212a

Chung, S.-C. (2018). Yoga and meditation in youth education: A systematic review. *The Lancet*, *392*, S24. https://doi.org/10.1016/S0140-6736(18)32052-X

Churches, R., & McAleavy, T. (2015). Evidence that counts—what happens when teachers apply scientific methods to their practice: Twelve teacher-led randomised controlled trials and other styles of experimental research. *CfBT Education Trust*.

Coe, R. (2017). Evaluation: Why, what and how. Impact, Interim Issue. Retrieved from https://impact.chartered.college/article/coe-evaluation-why-what-how/

Coldwell, M., Greany, T., Higgins, S., Brown, C., Maxwell, B., Stiell, B., … Burns, H. (2017). Evidence-informed teaching: An evaluation of progress in England*. Research Report*. Department for Education.

Commissar, L., & Brookman-Byrne, A. (2017). IMBES pre-conference: Using insight from research to improve education. *Mind, Brain, and Education*, *special issue IMBES*, 1–7. https://doi.org/10.1111/mbe.12159

Daniel, D. B. (2012). Promising principles: Translating the science of learning to educational practice. *Journal of Applied Research in Memory and Cognition*, *1*(4), 251–253. https://doi.org/10.1016/j.jarmac.2012.10.004

Daniel, E. (2007). Noise and hearing loss: A review. *Journal of School Health*, *77*(5), 225–231. https://doi.org/10.1111/j.1746-1561.2007.00197.x

Della Chiesa, B., Christoph, V., & Hinton, C. (2009). How many brains does it take to build a new light: Knowledge management challenges of a transdisciplinary project. *Mind, Brain, and Education*, *3*(1), 17–26. https://doi.org/10.1111/j.1751-228x.2008.01049.x

Dockrell, J. E., & Shield, B. M. (2006). Acoustical barriers in classrooms: The impact of noise on performance in the classroom. *British Educational Research Journal*, *32*(3), 509–525. https://doi.org/10.1080/01411920600635494

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*, *14*(1), 4–58. https://doi.org/10.1177/1529100612453266

Dusenbury, L., Brannigan, R., Falco, M., & Hansen, W. B. (2003). A review of research on fidelity of implementation: Implications for drug abuse prevention in school settings. *Health Education Research*, *18*(2), 237–256. https://doi.org/10.1093/her/18.2.237

Eagleman, D. M. (2013). Why public dissemination of science matters: A manifesto. *Journal of Neuroscience*, *33*(30), 12147–12149. https://doi.org/10.1523/JNEUROSCI.2556-13.2013

Eberhart, J., & Baker, S. T. (2018). The context and purpose of executive functions assessments: Beyond the tripartite model. Talk presented at the European Association for Research on learning and Instruction: Neuroscience and Education Special Interest Group, London, England.

Ellefson, M. R., Baker, S. T., & Gibson, J. L. (2019). Lessons for successful cognitive developmental science in educational settings: The case of executive functions. *Journal of Cognition and Development*, *20*(2), 253–277. https://doi.org/10.1080/15248372.2018.1551219

Enmarker, I., & Boman, E. (2004). Noise annoyance responses of middle school pupils and teachers. *Journal of Environmental Psychology*, *24*(4), 527–536. https://doi.org/10.1016/j.jenvp.2004.09.005

Erickson, L. C., & Newman, R. S. (2017). Influences of background noise on infants and children. *Current Directions in Psychological Science*, *26*(5), 451–457. https://doi.org/10.1177/0963721417709087

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience*, *14*(3), 340–347. https://doi.org/10.1162/089892902317361886

Felver, J. C., Celis-de Hoyos, C. E., Tezanos, K., & Singh, N. N. (2016). A systematic review of mindfulness-based interventions for youth in school settings. *Mindfulness*, *7*(1), 34–45. https://doi.org/10.1007/s12671-015-0389-4

Ferreira-Vorkapic, C., Feitoza, J. M., Marchioro, M., Simões, J., Kozasa, E., & Telles, S. (2015). Are there benefits from teaching yoga at schools? A systematic review of randomized control trials of yoga-based interventions. *Evidence-based Complementary and Alternative Medicine*, *2015*(345835), 1–17. https://doi.org/10.1155/2015/345835

Geldmacher, D. S. (1996). Effects of stimulus number and target-to-distractor ratio on the performance of random array letter cancellation tasks. *Brain and Cognition*, *32*(3), 405–415. https://doi.org/10.1006/brcg.1996.0073

Glennon, C., Hinton, C., Callahan, T., & Fischer, K. W. (2013). School-based research. *Mind, Brain, and Education*, *7*(1), 30–34. https://doi.org/10.1111/mbe.12004

Hobbiss, M., Massonnié, J., Tokuhama-Espinosa, T., Gittner, A., Arson de Sousa Lemos, M., Tovazzi, A., … Gous, I. (2019). UNIFIED: Bridging the researcher-practitioner divide in mind, brain and education. *Mind, Brain, and Education*, *13*(4), 298–312. https://doi.org/10.1111/mbe.12223

Howard-Jones, P., & Ioannou, K. (2018). *Implementing science of learning in initial teacher education: Conversations and concepts*. Retrieved from University of Bristol website: http://www.edneuro.net/SoLfITE-2017-2018.php

Howard-Jones, P., Ioannou, K., Bailey, R., Prior, J., Yau, S. H., & Jay, T. (2018). Applying the science of learning in the classroom. *Impact*, *2*, 9–12.

Hyland, K., & Tse, P. (2007). Is there an "academic vocabulary"? *TESOL Quarterly*, *41*(2), 235–253.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, *10*(2), 144–156. https://doi.org/10.1093/clipsy/bpg016

Kanakri, S. M., Shepley, M., Varni, J. W., & Tassinary, L. G. (2017). Noise and autism spectrum disorder in children: An exploratory survey. *Research in Developmental Disabilities*, *63*, 85–94. https://doi.org/10.1016/j.ridd.2017.02.004

Kelleher, I., & Whitman, G. (2018). A bridge no longer too far: A case study of one school's exploration of the promise and possibilities of mind, brain, and education science for the future of education. *Mind, Brain, and Education*, *Invited Submission*, 1–7. https://doi.org/10.1111/mbe.12163

Klatte, M., Bergström, K., & Lachmann, T. (2013). Does noise affect learning? A short review on noise effects on cognitive performance in children. *Frontiers in Psychology*, *4*, 578. https://doi.org/10.3389/fpsyg.2013.00578

Les Savanturiers—L'école de la recherche. (2018). *Education through research programme.* Retrieved from https://les-savanturiers.cri-paris.org/

Ljung, R., Sorqvist, P., & Hygge, S. (2009). Effects of road traffic noise and irrelevant speech on children's reading and mathematical performance. *Noise and Health*, *11*(45), 194–198. https://doi.org/10.4103/1463-1741.56212

Matusz, P. J., Dikker, S., Huth, A. G., & Perrodin, C. (2019). Are we ready for real-world neuroscience? *Journal of Cognitive Neuroscience*, *31*(3), 327–338. https://doi.org/10.1162/jocn_e_01276

Maxwell, L. E., & Evans, G. W. (2000). The effects of noise on pre-school children's pre-reading skills. *Journal of Environmental Psychology*, *20*(1), 91–97. https://doi.org/10.1006/jevp.1999.0144

McVay, J. C., & Kane, M. J. (2012). Why does working memory capacity predict variation in reading comprehension? On the influence of mind wandering and executive attention. *Journal of Experimental Psychology: General*, *141*(2), 302–320. https://doi.org/10.1037/a0025250

Morein-Zamir, S., & Sahakian, B. J. (2010). Neuroethics and public engagement training needed for neuroscientists. *Trends in Cognitive Sciences*, *14*(2), 49–51. https://doi.org/10.1016/j.tics.2009.10.007

Munakata, Y., Morton, J. B., & Yerys, B. E. (2003). Children's perseveration: Attentional inertia and alternative accounts. *Developmental Science*, *6*(5), 471–473. https://doi.org/10.1111/1467-7687.00302

Nathanson, J., A., & Berg, R E. (2019). Noise pollution. In *Encyclopedia Britannica*. Retrieved from https://www.britannica.com/science/noise-pollution

Norlander, T., Moås, L., & Archer, T. (2005). Noise and stress in primary and secondary school children: Noise reduction and increased concentration ability through a short but regular exercise and relaxation program. *School Effectiveness and School Improvement*, *16*(1), 91–99. https://doi.org/10.1080/092434505000114173

Pasquinelli, E. (2011). Knowledge-and evidence-based education: Reasons, trends, and contents. *Mind, Brain, and Education*, *5*(4), 186–195.

Perseveration. (n.d.). In *Merriam-Webster Online*. Retrieved from https://www.merriam-webster.com/dictionary/perseveration

Persevere. (n.d.). In *Merriam-Webster Online*. Retrieved from https://www.merriam-webster.com/dictionary/persevere

Pickering, S. J., & Howard-Jones, P. (2007). Educators' views on the role of neuroscience in education: Findings from a study of UK and international perspectives. *Mind, Brain, and Education*, *1*(3), 109–113. https://doi.org/10.1111/j.1751-228X.2007.00011.x

Plummer, B. D., Galla, B. M., Finn, A. S., Patrick, S. D., Meketon, D., Leonard, J., … White, R. E. (2014). A behind-the-scenes guide to school-based research. *Mind, Brain, and Education*, *8*(1), 15–20. https://doi.org/10.1111/mbe.12040

Rempel, K. (2012). Mindfulness for children and youth: A review of the literature with an argument for school-based implementation. *Canadian Journal of Counselling and Psychotherapy/Revue Canadienne de Counseling et de Psychothérapie*, *46*(3), 201–220.

Roediger, H. L., III, & Pyc, M. A. (2012). Inexpensive techniques to improve education: Applying cognitive psychology to enhance educational practice. *Journal of Applied Research in Memory and Cognition*, *1*(4), 242–248. https://doi.org/10.1016/j.jarmac.2012.09.002

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia*, *42*(8), 1029–1040. https://doi.org/10.1016/j.neuropsychologia.2003.12.012

Schmuckler, M. A. (2001). What is ecological validity? A dimensional analysis. *Infancy*, *2*(4), 419–436. https://doi.org/10.1207/S15327078IN0204_02

Shield, B., & Dockrell, J. E. (2004). External and internal noise surveys of London primary schools. *The Journal of the Acoustical Society of America*, *115*(2), 730–738. https://doi.org/10.1121/1.1635837

Shield, B. M., & Dockrell, J. E. (2003). The effects of noise on children at school: A review. *Building Acoustics*, *10*(2), 97–116. https://doi.org/10.1260/135101003768965960

Simmonds, A. (2014) *How neuroscience is affecting education: Report of teacher and parent surveys*. London, United Kingdom: Wellcome Trust.

Tang, Y.-Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., … others. (2007). Short-term meditation training improves attention and self-regulation. *Proceedings of the National Academy of Sciences*, *104*(43), 17152–17156. https://doi.org/10.1073/pnas.0707678104

Thomas, M. S. C., Ansari, D., & Knowland, V. C. P. (2019). Annual research review: Educational neuroscience: Progress and prospects. *Journal of Child Psychology and Psychiatry*, *60*(4), 477–492. https://doi.org/10.1111/jcpp.12973

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, *54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

Van Tonder, J., Woite, N., Strydom, S., Mahomed, F., & Swanepoel, D. W. (2015). Effect of visual feedback on classroom noise levels. *South African Journal of Childhood Education*, *5*(3), 1–6. https://doi.org/10.4102/sajce.v5i3.265

Willingham, D. T. (2009). Three problems in the marriage of neuroscience and education. *Cortex*, *45*(4), 544–545. https://doi.org/10.1016/j.cortex.2008.05.009

Woolner, P., & Hall, E. (2010). Noise in schools: A holistic approach to the issue. *International Journal of Environmental Research and Public Health*, *7*(8), 3255–3269. https://doi.org/10.3390/ijerph7083255

Zenner, C., Herrnleben-Kurz, S., & Walach, H. (2014). Mindfulness-based interventions in schools—A systematic review and meta-analysis. *Frontiers in Psychology*, *5*, 603. https://doi.org/10.3389/fpsyg.2014.00603