Check for updates

Received: 5 April 2023 | Revised: 7 September 2023 | Accepted: 16 September 2023
DOI: 10.1111/jcal.12879

ARTICLE

Journal of Computer Assisted Learning WILEY

Exploring the effects of seductive details and illustration dynamics on young children's performance in an origami task

Tiphaine Colliot[1] | Jean-Michel Boucheix[2]

[1]Centre de Recherches sur la Cognition et l'Apprentissage, CeRCA, Université de Poitiers, Poitiers, France

[2]LEAD-CNRS, UMR5022, Université Bourgogne, Dijon, France

Correspondence
Tiphaine Colliot, Centre de Recherches sur la Cognition et l'Apprentissage, CERCA-CNRS UMR 7295 MSHS-5, rue Théodore Lefebvre, 86073 Poitiers, France.
Email: tiphaine.colliot@univ-poitiers.fr

Abstract

Background: Previous studies have shown that dynamic illustrations, as compared to their static counterparts, lead to higher achievement levels, especially for hand-based procedures. Other researchers have investigated how the presence of seductive details (i.e., appealing but irrelevant adjunct displays) influences students' interest positively but their learning negatively.

Objectives: The purpose of the two present studies was to investigate the effects of animated versus static presentations, combined with the presence of seductive details, on student performance on a paper-folding task (i.e., origami) in a naturalistic school environment.

Methods: Fifty-five children (5–6 years old) participated in the first study and were randomly assigned to one of four groups. The second study was conducted with older children (72 s or third graders) and a more complex origami task.

Results and Conclusions: In the first study, results demonstrated negative effects of seductive details on children's performance and time on task, but no effects of presentation format. In the second study, no negative effects of seductive details on student achievement were found, but animated illustrations significantly improved children's performance and reduced time on task. However, seductive details tended to impair learning more greatly given the presence of static, as compared to animated, presentations. Task difficulties and pupils' ability to inhibit irrelevant information may explain these results.

KEYWORDS
animated illustrations, hand-gesture procedure, learning performance, seductive details, static illustrations

1 | INTRODUCTION

How should one present information effectively so that it promotes the student learning experience (e.g., satisfaction, interest, and motivation) and achievement? Learning from a multimedia document is now a common practice for pupils in educational settings. There are many ways to present information to a learner in a multimedia document. Moreover, pedagogical designs choices are critical, as they can greatly influence students' information processing and, in turn, their learning performance (see Mayer's multimedia principles, Mayer & Fiorella, 2021; Torkar, 2022). In two experimental studies conducted in naturalistic environments, we investigated the effects of illustration type, specifically static versus dynamic, as well as the effects of the presence of seductive details, on young children's performance during an origami task.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2023 The Authors. *Journal of Computer Assisted Learning* published by John Wiley & Sons Ltd.

1.1 | The effects of using dynamic illustrations to present procedural knowledge on learning

"Animations," with this term referring to "any application which generates a series of frames, so that each frame appears as an alteration of the previous one, and where the sequence of frames is determined either by the designer or the user" (Bétrancourt & Tversky, 2000, p. 313), are an increasingly common component of multimedia learning materials in schools. They are widely considered to be an intrinsically effective way of presenting dynamic subject matter to learners, particularly if it is complex and unfamiliar to the target audience. However, research suggests that animated graphics are not necessarily superior to their static counterparts as aids to understanding (Berney & Bétrancourt, 2016; Lowe et al., 2022). One of the main challenges regarding animation processing is related to its transience (Lowe & Boucheix, 2008; Spanjers et al., 2011). When learners are presented with transient information, they must simultaneously store, process, and link both previous and current information. Learning transient information can be very demanding and can result in the severe impairment of the quality of the mental model built from the animation (Lowe & Boucheix, 2008, 2011). Thus, transient information can be considered to have negative cognitive load consequences for learners' working memory (Leahy & Sweller, 2011; Lowe, 1999; Sweller et al., 2011; Wong et al., 2012). It could be hypothesized that such a negative effect could even be higher for young children, who may not have the same cognitive control or executive function abilities as adults (see Barrouillet et al., 2007). However, all the four meta-analyses comparing the effectiveness of static and animated graphics, or images, indicated a positive effect on the part of animations, as compared to static presentations, on learning and comprehension (Berney & Bétrancourt, 2016; Castro-Alonso et al., 2019; Höffler & Leutner, 2007; Ploetzner et al., 2020). In the three first meta-analyses, a small to medium-sized positive effect on the part of animations was found (0.37, 0.22, and 0.23, respectively). Ploetzner et al. (2020) proposed new moderators influencing learning outcome performance: the spatio-temporal changes displayed in the animation or video and their complexity level. The results showed that animations can be more effective than static graphics when complex time-related features, such as velocity or accelerations, are displayed.

These meta-analyses, combined with previous research, indicate that animated presentations are particularly beneficial and superior to their static counterparts when learning materials are based on human movements, especially hand-based procedures (Ayres et al., 2009; Boucheix & Forestier, 2017; Brucker et al., 2015), due to the human ability to learn movement tasks by observation (Arguel & Jamet, 2009). The results of these research were very similar in a diversity of procedures; origami and lego, Marcus et al. (2013), knots tying, Schwan & Riempp (2004), Wong et al. (2009), Wong et al. (2012); for a review in relation with the mirror neurons system theory, see van Gog et al. (2009). In this regard, one explanation of this ability to learn movements by direct observation is the existence of a highly effective mirror neuron system (Rizzolatti & Craighero, 2004; see also van Gog et al. 2009). Boucheix and Forestier (2017) proposed a complementary explanation they termed the "static presentation effect on cognitive load" (p. 359, see also Jiang & Sweller, 2022). Previous research has often argued that the processing difficulties related to the transience of animation do not occur with static graphics, because the information remains available to the learners (Ayres et al., 2009; Bétrancourt, 2005; Boucheix & Schneider, 2009; Ganier & de Vries, 2016; Hegarty et al., 2003; Jiang & Sweller, 2022; Mayer et al., 2007). However, processing a series of static pictures involves inferring the dynamics involved from the presentation of the key steps. This processing activity requires the ability to use prior knowledge of the subject matter, especially for young children, and also depends on the temporal distance between the presented key frames. Furthermore, when the task involves long procedures, static graphics could demand a high level of visual searching between pictures, the inhibition of non-relevant information, and, thus, competition for attention (Barrouillet et al., 2007; Boucheix & Forestier, 2017; Lowe & Boucheix, 2016). In a study about first aid learning from videos, Arguel and Jamet (2009) found that the number of static pictures mattered greatly. This is in line with Boucheix and Forestier (2017), who hold that the extra processing demands required by a series of static pictures may increase the extraneous cognitive load (Paas & Sweller, 2014). Finally, presenting a dynamic series of events with static pictures could break the visual continuity of the procedure, especially the hand dynamics (see the "attentional theory of cinematic continuity"—AToCC—by Smith, 2012; Smith et al., 2012). Temporal continuity may help the memorization of continuous events display, especially hand procedures.

Among the many studies that have compared learning from dynamic versus static presentations, most have involved adults; young adults, mostly university students; or secondary or high school pupils. Only a few of these studies involved younger children (e.g., Boucheix & Guignard, 2005; Cook et al., 2017; Post et al., 2013), and even fewer studies concerned hand procedure learning (e.g., Boucheix & Forestier, 2017, for knots tying, and Wong et al., 2012, for origami). The children who participated in these studies were between 8 and 11 years old and at the end of elementary school. Just like adults, it seems that primary school children learn more from animated presentations than from static presentations given the same procedural content. For example, in an origami task with 10–11-year-old children, Wong et al. (2012, Experiment 1) showed that, when transient information was presented in short sections, animations were found to be superior to static graphics, so the ability to learn by observing is possessed by primary school children. However, when transient information was presented in long sections, animations tended to lose their superiority to static graphics, with this likely being related to the larger amount of information being presented. These results were partially replicated in a task that consisted in tying nautical knots with 10–11-year-old children (Boucheix & Forestier, 2017, Experiment 1). The children required significantly less time to learn to tie the nautical knots in the dynamic presentation condition than in the static counterpart condition. However, the results indicated that animations divided in long sections did not always lose their superiority to static graphics. It was argued that a series of static graphics could (i) increase inhibition-related processing demands within and between pictures, (ii) break the attentional continuity advantage of natural dynamic procedure, and (iii) lower task

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

affordance benefits. Continuous hand and rope movements together may provide "natural human movements cues" that are useful for children mimicking gestures, which could facilitate the linking of microsteps and overall learning.

To our knowledge, no studies testing the superiority of animations to static graphics in teaching a hand procedure (origami) have been conducted with children from 5 to 8 years old. Processing dynamic information could be perceptually and cognitively demanding for kindergarten-age children, but due to humans' ability to learn procedures from observation, a dynamic presentation could still prove superior to static graphics. In addition, often to increase motivation and learning engagement, educational multimedia materials used for young children include attractive decorations and seductive details. Such additions on may influence the effect of a dynamic or static presentation, and this issue is explored in the next section.

1.2 | How do seductive details influence student learning?

Seductive details are defined as "interesting but irrelevant information that are not necessary to achieve the instructional objective" (Rey, 2012, p. 216). To make a lecture more appealing and to trigger learners' interest and motivation, some instructors may be tempted to use several seductive details in their multimedia documents (Bender et al., 2021a). According to Moreno's cognitive-affective theory of learning with media (CATLM, Moreno, 2006, 2009; Moreno & Mayer, 2007; see also Schneider et al., 2021's cognitive-affective-social theory of learning in digital environments, CASTLE), motivation is a critical learning-regulation process that can increase students' learning by fostering generative processes. Indeed, motivation can positively influence learners' efforts to invest in deep information processes and, therefore, their engagement in the learning task (Mayer, 2014a, 2014b). To this end, some studies have demonstrated that decorative pictures, which are considered seductive details, can enhance student interest (e.g., Magner et al., 2014; Wang & Adesope, 2016). A few studies also found positive effects on the part of seductive details on learning outcomes under specific conditions (e.g., Fries et al., 2019; Ketzer-Nöltge et al., 2018; Lehmann et al., 2019; Wang et al., 2021).

However, several meta-analyses have highlighted the negative overall effects of seductive details on learning performance (Rey, 2012; Sundararajan & Adesope, 2020; see also Noetel et al., 2022). More specifically, in Rey's meta-analysis (Rey, 2012), a small to medium effect size was found for retention performance ($d = 0.30$) and a medium effect size was found for transfer performance ($d = 0.48$). This refers to the seductive detail principle, which asserts that people learn more deeply from a multimedia presentation when interesting but unimportant adjuncts are excluded (Rey, 2014, p. 133). This principle is linked to the coherence principle, which holds that people learn better when extraneous words and images are excluded (Mayer & Fiorella, 2021). The presence of seductive details would add extraneous cognitive load (i.e., the load is determined by how the information is presented and linked to the instructional design of a multimedia document; Sweller et al., 2019), which is irrelevant to learning. More specifically, seductive details may consume some of the learner's limited cognitive resources, which could have been devoted to deeply processing the relevant information from the multimedia document. As stated by Eitel et al. (2018, p. 21), "Seductive details are detrimental to learning because they make it harder for students to select and integrate relevant information into a coherent mental representation (reflected in increased ECL) or simply because they require the processing of additional information that is irrelevant to performing well in the posttest."

In Magner et al. (2014), 8th grade students worked with a cognitive tutor geometry lesson, either with interesting decorative illustrations or without these illustrations. The results confirmed that viewing these seductive details increased students' situational interest. Moreover, the results showed a differentiated effect on learning depending on students' prior knowledge: low-prior-knowledge students performed better on a near-transfer task without seductive details (consisting in "problems with the same structure or solution rationale but different surface features such as objects and numbers," Atkinson et al., 2003, p. 775) whereas high-prior-knowledge students performed better on a near-transfer task when they were provided with seductive details. These results are in line with those obtained by Park et al. (2011) who showed that seductive details positively influenced learning under a low load condition (see also Korbach et al., 2016). In Wang and Adesope's study (Wang & Adesope, 2016), 9th graders studied either a base-only passage about geology or the same passage but with seductive details. Their results showed that learners in the seductive details group rated the learning material more highly in terms of triggering situational interest. However, mediation analyses revealed that the triggering of learners' situational interest was a significant negative predictor of their recall performance. According to Wang and Adesope (2016), these negative effects stem from the fact that learners' situational interest was triggered by irrelevant information, which, in turn, impaired their learning. In addition, recording learners' eye-tracking behaviours while studying a text containing seductive illustrations revealed that learners with low working memory capacities looked more frequently at and spent a more time on seductive illustrations as compared to learners with high memory capacities (Sanchez & Wiley, 2006). Thus, seductive details would be detrimental to novice learners', as they decrease their attention to relevant information (Alemdag & Cagiltay, 2018; Park et al., 2015). Overall, studying with seductive illustrations decreases the fixation duration on relevant text areas (Park et al., 2020).

An interesting study conducted by Eitel et al. (2018) showed that the negative effect on the part of seductive detail on learning outcomes is not observed when learners are informed about the details' irrelevance (see Bender et al., 2021a for similar results). Students being aware of the irrelevance of this information could help them control their cognitive processing and ignore it, thus avoiding becoming distracted during studying (on the self-management of cognitive load, see Eitel et al., 2020). When students process seductive details without being informed that this information is irrelevant, they can construct mental models based on these seductive details, which will impair their learning performance (diversion process, Bender et al., 2021b).

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Finally, recent research has shown that seductive details are detrimental to novice learners, even if they can increase their situational interest (e.g., Rey, 2012; Sundararajan & Adesope, 2020). These details can distract learners' attention from the relevant information and disturb their elaboration of a coherent mental model integrating the critical information from the multimedia document (Alemdag & Cagiltay, 2018; Bender et al., 2021b; Park et al., 2015, 2020).

1.2.1 | Overview of the current studies and hypotheses

To date, no studies have ever investigated how the effects of animation, combined with seductive details, influence learning. On one hand, research about the benefits of animations over their static counterparts showed that significant differences between dynamic and static visualizations were more regularly obtained when learning procedural knowledge than when learning declarative or conceptual knowledge (e.g., Ayres et al., 2009; Boucheix & Forestier, 2017; Brucker et al., 2015). Moreover, in the four meta-analyses comparing the effectiveness of static and animated illustrations on learning, the effect size found in favour of the animation was higher for procedural knowledge and motor tasks than for declarative and conceptual knowledge (Berney & Bétrancourt, 2016; Castro-Alonso et al., 2019; Höffler & Leutner, 2007; Ploetzner et al., 2020, see also Lowe et al., 2022). On the other hand, as far as we know, seductive details have been researched widely when learners read expository text, multimedia presentations, or watch a video about a scientific topic. Therefore, the question remains as to whether, the difference between dynamic and static presentation formats will be preserved and especially if seductive details still distract learners' attention and/or overload their limited working memory when they are performing hand-gesture tasks.

Furthermore, most previous studies have been conducted with university students. The two present studies aimed to test the effects of animated illustrations, combined with seductive details, on primary school children. Moreover, as emphasized recently in the meta-analysis of Sundararajan and Adesope (2020), there have been only a few investigations of seductive details in the classroom. This is why we conducted these studies in naturalistic environments with children.

Furthermore, seductive details are often placed around relevant areas during a learning task, which means that learners must process them so that the negative effects appear. This also explains why informing students about their irrelevance can prevent the negative effects of seductive details, as learners no longer process this information (Eitel et al., 2018). However, sometimes, seductive details are inseparable from the areas that must be processed to complete the learning task. Here, we chose to use material in which the seductive details were placed in the relevant areas that children had to process. The students saw an origami constructed with either a blank piece of paper (without seductive details) or with a piece of printed design paper (with seductive details). To our knowledge, the present two studies are the first to test the superiority of animations to static graphics, combined with the effects of seductive details, in learning a hand-gesture procedure (origami) with young children in a naturalistic environment.

Based on previous studies regarding students' achievement for the task, we expected positive effects on the part of animation (H1a, Boucheix & Forestier, 2017) and negative effects on the part of seductive details (H1b, Sundararajan & Adesope, 2020). We also expected that the negative effects of seductive details to be greater in the static illustrations groups, as the cognitive load would be higher in this group (H1c).

Similar effects were expected regarding the time spent on the task: viewing animated illustrations would reduce the time spent on the task (H2a), while seductive details would increase it (H2b). An interaction between illustration types and seductive details was also expected: the time spent on the task would be the highest in the static illustrations group with seductive details (H2c).

Regarding students' situational interest, following previous studies, we hypothesized that viewing seductive details would increase students' situational interest (H3a, Magner et al., 2014). We also expected a positive effect on the part of animated illustrations on students' interest (H3b, Bétrancourt & Tversky, 2000).

Concerning cognitive load, we hypothesized that viewing static illustrations would lead to a higher cognitive load, as students would need to infer the dynamics from the presentation of the key steps (H4, Boucheix & Forestier, 2017). Two alternative hypotheses could be made regarding the effects of seductive details on students' cognitive load. On one hand, seductive details could increase students' cognitive load, as they consume their limited cognitive resources for the sake of irrelevant information processing. On the other hand, by making the document more appealing and targeting students' situational interest, these details could decrease students' perceptions of the cognitive load induced by the learning situation. Therefore, no hypothesis was made concerning the effects of seductive details on cognitive load.

2 | EXPERIMENT 1

2.1 | Method

2.1.1 | Participants and design

Previous research about the effects of seductive details on learning indicated small to medium effect sizes (see the meta-analyses by Noetel et al., 2022; Rey, 2012; Sundararajan & Adesope, 2020). Based on a small to medium effect size for a two-way ANOVA analysis, that is two between subjects factors corresponding to the two factors of the present experiment (i.e., Presence or Absence of seductive details and Format, Static vs. Animated) we performed two power analyses: (1) The compromise power analysis (compute implied α and power, −given β/α ratio, sample size and effect size) conducted with G*power 3.1 (Faul et al., 2007) showed for an effect size f of 0.25, a β/α ratio of 1 and a power (1 − β err.prob.) reaching 0.75 of a sample of 55 participants; (2) A sensitivity power analysis was performed with

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

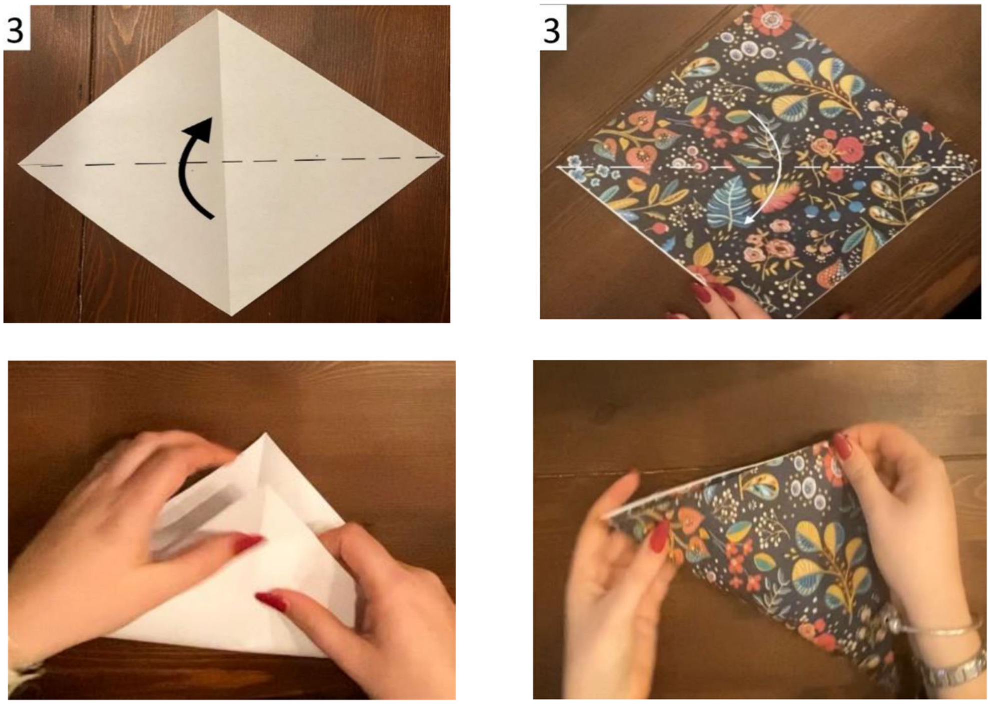

FIGURE 1 Illustrations of the four study conditions: static illustrations without seductive details (top left), static illustrations with seductive details (top right), animated illustrations without seductive details (bottom left), and animated illustrations with seductive details (bottom right).

G*Power 3.1 (Faul et al., 2007) to estimate the minimum effect size detectable for a factorial ANOVA with the four groups ($n = 21$–23). This analysis indicated that for a power ($1 - \beta$ err.prob.) of 0.80, a medium effect size f of 0.38 would be detectable with the current sample size.

Fifty-five children in their last year of nursery school ($M_{age} = 5.6$ - years old, 28 girls and 27 boys) from three different classrooms took part in this study. All the children engaged in a paper-folding task to reproduce an origami representing a cat's head.

The experiment followed a 2×2 design in which the type of illustrations (static vs. animated) and seductive details (with or without) were between-subject factors. This resulted in four experimental groups to which children were assigned randomly: static illustrations without seductive details ($n = 15$), static illustrations with seductive details ($n = 15$), animated illustrations without seductive details ($n = 13$), and animated illustrations with seductive details ($n = 12$, see Figure 1).

2.1.2 | Material

In both animated illustration groups, children saw a video of the origami folding actions on a tablet computer. Each child in the animated groups had an individual tablet computer on which to watch the video and had the chance to pause and navigate through the video. In the static-illustrations groups, children were provided with a small booklet composed of eight pages, with each page containing one image. The eight images depicted the eight actions children had to perform in order to reproduce the origami. The actions were described using arrows and dotted lines on top of the pictures (see Figure 1). The paper-folding actions shown on the paper or on video were performed with either a blank sheet of paper (without seductive details) or a printed design paper composed of various drawings (with seductive details; see Figure 1). In the animated-illustrations-with-seductive-details group, three small drawings of animals appeared during the folding actions on the corner of the video. In the animated-illustrations groups, the video lasted 2 min 16 s without seductive details and 2 min 40 s with seductive details. All the children were provided with a blank sheet of paper to reproduce the origami while watching the video or looking at the illustrations they were provided with.

2.1.3 | Measures

Cognitive load

Participants were asked to rate their perceived cognitive load during the task on a 5-point Likert scale item that ranged from 1 (very difficult) to 5 (very easy). Each point of the scale was associated with a coloured smiley face to help the children position themselves on the scale. The question used was as follows: "Did you find this activity difficult to realize?" This item was adapted from the item used by Moreno and Valdez (2005) and DeLeeuw and Mayer (2008). To facilitate data interpretation, the results were reversed so that a high score indicated a high cognitive load perception.

Situational interest

The children were also asked to rate their situational interest in the paper-folding task on a 5-point Likert scale item that ranged from 1 (did not like it at all) to 5 (liked it very much). As with the cognitive load item, each point of the scale was associated with a coloured smiley face to help the children position themselves on the scale. The

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

question used was as follows: "Did you find this activity interesting?" This item was adapted from Frechette and Moreno's interest/motivation dimension (Frechette & Moreno, 2010) and Rotgans and Schmidt's situational interest scale (Rotgans & Schmidt, 2014).

Children's achievement

When a child finished the paper-folding task, the schoolteacher collected the origami they had constructed and noted the participant's code on it. This allowed us to assess the children's achievement by counting the number of steps, out of eight, that they performed correctly in constructing the origami. The origamis could be partially constructed, constructed with some errors, or perfectly constructed.

Time spent on task

All the children began this activity at the same time. Each produced the origami individually, at their own pace, on a blank sheet of paper. A timer was used to measure the time taken to perform the paper-folding task. When a child considered that he or she had finished the task, he or she was asked to raise his or her hand to indicate this to the teacher. Therefore, the time spent on task consisted of the time elapsed between when the children started the activity and the time they raised their hands. In addition, a time limit of 10 min was set for the task.

2.1.4 | Procedure

First, the children were told about the different steps involved in the study. They were also informed of the study duration, that is, the time limit of 10 min in which to construct the origami. The task was performed individually in the classroom. Depending on their study group, the children performed the task either while viewing a video on a tablet computer (the animated illustrations groups) or using a booklet composed of eight pages (one image per page for the static illustrations groups). They were allowed to navigate freely through the video and the pages of the booklet during the task. However, the children were told that the teacher would not help them in the paper-folding task and that they had to create the origami by themselves. The children were also instructed to raise their hand quietly when they believed that they had finished the origami. Before beginning the task, the teacher ensured that all the children understood the instructions and had no questions. When the teacher collected an origami, the child was provided with the subjective rating scales to complete. If a child had finished the task rapidly, the teacher would give them colouring pages to help them wait patiently.

2.1.5 | Data analysis

We ran a MANOVA to test the effects of the conditions on the various measures collected in this study: achievement, time spent on task, perceived situational interest, and cognitive load. The significant main effect obtained were followed up with ANOVAs for each dependent variable. The means and SDs of each group for the various measures are displayed in Table 1. All the analyses were conducted using Jamovi computer software (see the Jamovi Project, 2019; R Core Team, 2018).

2.2 | Results

The MANOVA revealed a significant main effect of seductive details Wilk's Lambda $= 0.790$, $p = 0.021$, but no significant main effect for the type of illustrations, Wilk's Lambda $= 0.904$, $p = 0.294$. There was also no significant interaction effect, Wilk's Lambda $= 0.918$, $p = 0.380$.

2.2.1 | Children's achievement

Children's achievement was calculated by counting the number of steps they correctly performed in constructing the origami. The analysis revealed a significant main effect for seductive details, $F(1, 51) = 9.072$, $p = 0.004$, $\eta^2 = 0.151$ (supporting H1b) but no significant main effect for the type of illustrations, $F(1, 51) = 0.049$, $p = 0.826$, $\eta^2 = 0.001$ (contradicting H1a). In addition, contrary to H1c, the interaction between types of illustrations and seductive details was not significant, $F(1, 51) = 0.148$, $p = 0.702$, $\eta^2 = 0.002$. The results showed that children in the groups without seductive details (i.e., static illustrations without seductive details and animated illustrations without seductive details) outperformed children in the groups with seductive details (i.e., static illustrations with seductive details and animated illustrations with seductive details). More specifically, when children performed the task by viewing a blank sheet of paper they outscored those who viewed the folding actions with a printed design paper ($M = 7.14$ of correct actions out of 8 vs. and $M = 5.63$, respectively).

2.2.2 | Time spent on task

In accordance with H2b, the ANOVA revealed a main effect for seductive details on the amount of time spent on task, $F(1, 51) = 8.93$, $p = 0.004$, $\eta^2 = 0.139$. However, no significant main effect for the type of illustrations was obtained, $F(1, 51) = 1.83$, $p = 0.182$, $\eta^2 = 0.028$, which contradicts H2a. In addition, the interaction between the type of illustrations and the presence of seductive details was not significant, $F(1, 51) = 2.67$, $p = 0.108$, $\eta^2 = 0.041$ (contradicting H2c). The results revealed that adding seductive details increased the time spent on the task ($M = 5.15$ min, on average, in both groups without seductive details versus $M = 7.08$ min, on average, in both groups with seductive details).

2.2.3 | Situational interest

The ANOVA showed no main effect for the type of illustrations children were provided with (static vs. animated) on their perceived

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 Mean percentages (and standard deviations) for outcome variables by group for Experiment 1.

	Without seductive details		With seductive details	
	Static illustrations ($n = 15$)	Animated illustrations ($n = 13$)	Static illustrations ($n = 15$)	Animated illustrations ($n = 12$)
% of steps correctly achieved	87.5 (22.2)	91.3 (11.8)	70.8 (22.0)	69.8 (33.9)
Time spent on task (min.)	4.29 (1.38)	6.15 (2.38)	7.16 (2.51)	6.98 (2.76)
Situational interest/5	4.27 (1.39)	4.23 (1.09)	3.67 (1.76)	4.33 (1.23)
Cognitive load/5	1.87 (1.30)	2.00 (1.63)	3.13 (1.55)	2.42 (1.78)

interest in the task, $F(1, 51) = 0.683$, $p = 0.413$, $\eta^2 = 0.013$. There was also neither a main effect for the presence of seductive details, $F(1, 51) = 0.425$, $p = 0.518$, $\eta^2 = 0.008$, nor an interaction effect between the type of illustrations and the presence of seductive details, $F(1, 51) = 0.847$, $p = 0.362$, $\eta^2 = 0.016$. These results contradict H3a and H3b.

2.2.4 | Cognitive load

The ANOVA revealed no main effect for the type of illustrations children were provided with (static vs. animated) on their ratings of the cognitive load induced by the task, contradicting H4, $F(1, 51) = 0.475$, $p = 0.494$, $\eta^2 = 0.008$. A marginal effect for seductive details was observed, $F(1, 51) = 3.957$, $p = 0.052$, $\eta^2 = 0.070$, in that children viewing illustrations without seductive details found the task easier as compared to those who viewed illustrations with seductive details. Analyses revealed no significant interaction effect, $F(1, 51) = 1.009$, $p = 0.320$, $\eta^2 = 0.018$.

2.3 | Discussion of experiment 1

The results revealed that seductive details negatively influenced children's performance. Children given seductive details performed better during the paper-folding task as compared to those who were not given the seductive details. Seductive details also increased the time spent on task. These results are in line with previous meta-analyses depicting the negative effects of irrelevant information on comprehension. This is also in accordance with the seductive detail principle and the coherence principle, which state that extraneous material should be excluded from multimedia documents (Mayer & Fiorella, 2021; Rey, 2014; Sundararajan & Adesope, 2020; see also Bender et al., 2021a).

Furthermore, contrary to our expectations and previous research, seductive details did not heighten children's situational interest (e.g., Wang & Adesope, 2016). However, the data on situational interest revealed that all the students were greatly motivated by the paper-folding task (around 75% of children positioned themselves at point 4 or 5 on the 5-point Likert scale).

In addition, a marginal effect was observed regarding the cognitive load induced by the task: children in the seductive-details groups tended to perceived the task as inducing more cognitive load when seductive details were present in the pedagogical material. This result emphasizes the negative effects of seductive details on children's learning experience.

Contrary to our expectations, no positive effects on the part of animations were found, even though the material concerned a dynamic procedure. The fact that animated illustrations did not influence student performance contradicts previous findings (e.g., Castro-Alonso et al., 2019; Ploetzner et al., 2020). The absence of positive effects on the part of animation could stem from the relative easiness of the task. This paper-folding task was composed of only eight easy steps, as it was conducted with 5–6-year-old children), and around 80% of them successfully performed the task, indicating a ceiling effect. As shown by previous researchers, the positive effects of animations are mainly observed when the dynamic task is challenging (Lowe et al., 2022). In the present situation, the task may have been too easy to benefit from an animated presentation of the procedure as compared to a static presentation.

The study has also certain limitations. First, children in the animated-illustrations groups had the material presented on a tablet computer, while the static-illustration groups viewed the illustrations on paper. Handling a booklet is different from manipulating a numerical tool such as a tablet and students can be more or less at ease with the use of this type of technology. Moreover, the use of tablet computers may have influenced children's studying experience and cognitive load, as well as their perceived situational interest in the task. Furthermore, it may have also influenced the time spent on task and their involvement in completing the origami. However, recent studies have shown that the medium used (paper vs. tablet) does not influence text comprehension for children with high reading comprehension skills (Delgado & Salmerón, 2022; Salmerón et al., 2021). Second, the printed design paper used in both conditions "with seductive details" was dark/gloomy as the background of the printed design paper was a deep grey (see Figure 1). It is possible that such a colour tended to blur the folding lines intended to help in the construction of the origami in both "with seductive details" conditions. Thirdly, three drawings of animals appeared in the animated-illustrations-with-seductive-details group, which did not appear in the static illustrations group with seductive details. Finally, the origami used was composed of only eight easy steps. This choice was made because of the children's age.

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

3 | EXPERIMENT 2

In Experiment 2, all these potential biases were overcome by (i) choosing a lighter and brighter printed design paper, (ii) removing the drawing of animals appearing in the animated-illustrations group with seductive details, and (iii) using tablet computers in all the four study groups. In addition, we chose to pursue this study with older children (second and third grade), but they were still in their naturalistic classroom environments.

The hypotheses were the same as those formulated in Experiment 1.

3.1 | Method

3.1.1 | Participants and design

As in experiment 1, based on a small to medium effect size for a two-way ANOVA analysis, that is two between subjects factors corresponding to the two factors of this experiment (i.e., Presence or Absence of seductive details and Format, Static vs. Animated) we performed two power analyses: (1) The compromise power analysis (compute implied α and power, -given β/α ratio, sample size and effect size) conducted with G*power 3.1 (Faul et al., 2007) showed for an effect size f of 0.25, a β/α ratio of 1 and a power ($1 - \beta$ err.prob.) reaching 0.80 of a sample of 72 participants; (2) A sensitivity power analysis was performed with G*Power 3.1 (Faul et al., 2007) to estimate the minimum effect size detectable for a factorial ANOVA with the four groups ($n = 15$–19). This analysis indicated that for a power ($1 - \beta$ err.prob.) of 0.90, a medium effect size f of 0.38 would be detectable with the current sample size.

Forty-eight second graders and 24 third graders (Mage = 8.01 - years old, SD = 0.55, 37 girls and 35 boys) from four classrooms took part in this study. The overall sample was composed of 72 children. As in Experiment 1, all the children engaged in a paper-folding task to reproduce an origami. This time, the origami represented an ice cream.

Like Experiment 1, this experiment followed a 2 × 2 design in which the type of illustrations (static vs. animated) and seductive details (with or without) were between-subject factors. This resulted in four experimental groups to which the children were randomly assigned: static illustrations without seductive details ($n = 19$), static illustrations with seductive details ($n = 19$), animated illustrations without seductive details ($n = 19$), and animated illustrations with seductive details ($n = 15$; see Figure 2).

3.1.2 | Material

In both animated-illustration groups, the children saw a video of the creation of the origami on a tablet computer. Each child in the animated-illustration groups had an individual tablet computer on which to watch the video and had the chance to pause and navigate freely through the video. In the static-illustrations groups, the children saw static illustrations on a tablet computer. The document they saw on the tablet was composed of 14 pages, with each page containing one image (i.e., screenshots of the video). The 14 images depicted the 14 actions the children had to perform in order to reproduce the origami. These actions were described by using blue arrows in the pictures (see Figure 2). The paper-folding actions in the provided document were either performed with a blank sheet of paper (without seductive details) or with a printed design paper composed of various drawings (with seductive details; see Figure 2). In the animated groups, the video lasted 3 min 44 s without seductive details and 3 min 41 s with seductive details. All the children were provided with a blank sheet of paper to reproduce the origami while watching the video or studying the various illustrations they were provided with.

3.1.3 | Measures

The measures collected were the same as those in Experiment 1: cognitive load, situational interest, children's achievement, and time spent on task. In Experiment 2, children had to follow 14 steps, instead of the eight in Experiment 1, to complete the ice cream origami.

3.1.4 | Procedure

The procedure was identical to that used in Experiment 1, except that the time limit in which to construct the origami was set to 20 min, instead of the 10 min allotted to construct a cat's head in Experiment 1.

3.1.5 | Data analysis

The same data analysis procedures used in Experiment 1 were used to analyse the collected data of Experiment 2.

3.2 | Results

The MANOVA revealed a significant main effect for the type of illustrations Wilk's Lambda = 0.682, $p < 0.001$, but no significant main effect of seductive details, Wilk's Lambda = 0.914, $p = 0.202$. There was also no significant interaction effect, Wilk's Lambda = 0.938, $p = 0.373$.

3.2.1 | Children's achievement

The children's achievement was calculated by counting the number of steps they correctly performed to construct the origami. The analysis revealed no significant main effect for seductive details, $F(1, 68) = 0.180$, $p = 0.672$, $\eta^2 = 0.002$ (contradicting H1b). However, a

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

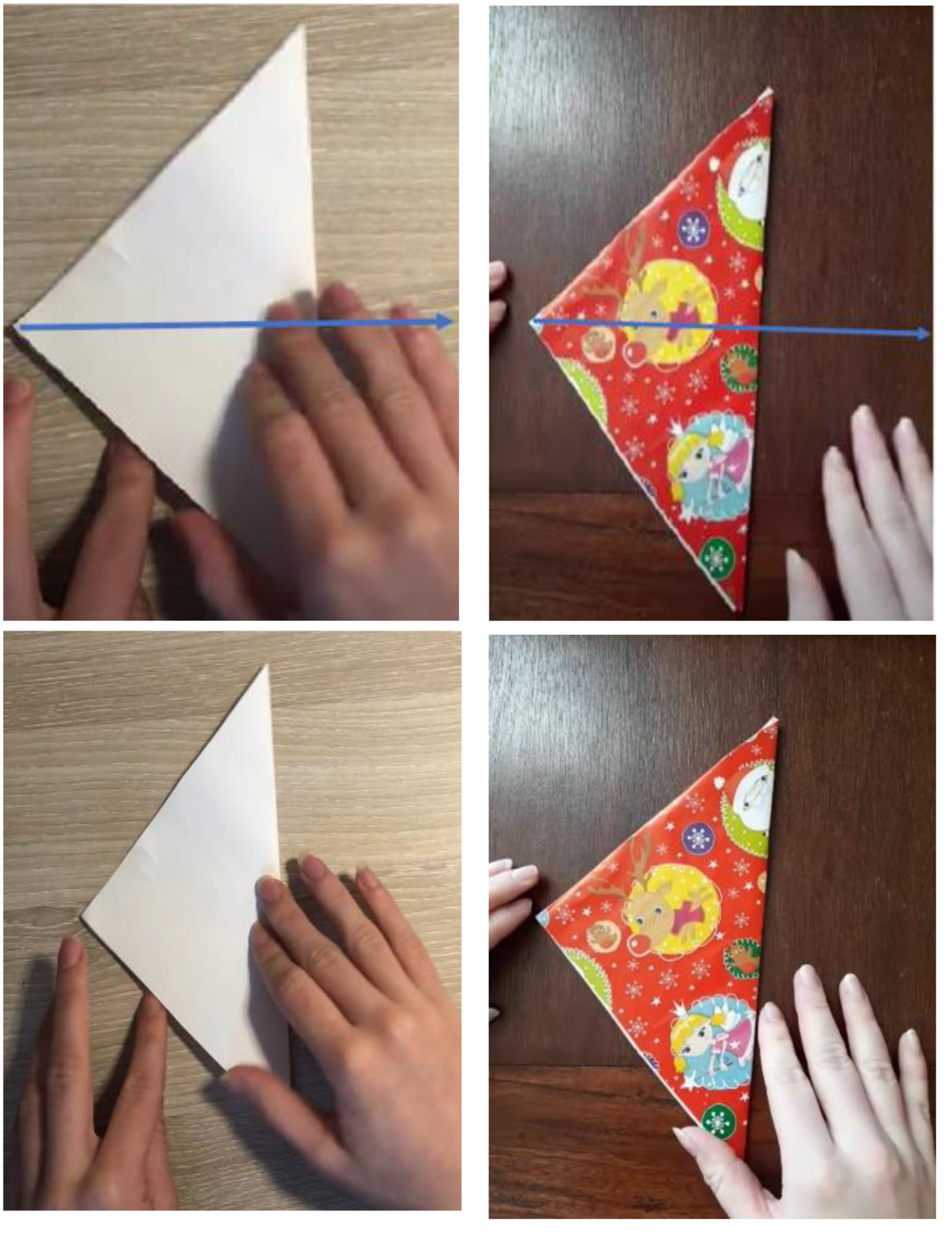

FIGURE 2 Illustrations of the four study conditions in Experiment 2: static illustrations without seductive details (top left), static illustrations with seductive details (top right), animated illustrations without seductive details (bottom left), and animated illustrations with seductive details (bottom right).

significant main effect for the type of illustrations was observed on children's achievement, $F(1, 68) = 12.141$, $p < 0.001$, $\eta^2 = 0.149$. Also, contrary to H1c, the interaction between the type of illustrations and the presence of seductive details was not significant, $F(1, 68) = 1.097$, $p = 0.299$, $\eta^2 = 0.013$. Following H1a, the results showed that children in the animated-illustrations groups, with or without seductive details, outperformed those in the static-illustrations groups, with or without seductive details. However, it is interesting to note, based on Table 2, that viewing static illustrations tended to more strongly impair performance when seductive details were present (59.8%) than when seductive details were absent (70.7%), but this difference–observed based on a planned comparison between these two groups–was not significant, $t(68) = 1.075$, $p = 0.286$, Cohen's $d = 0.35$. Furthermore, a planned comparison also showed that the difference between the animated and static formats, in the absence of seductive details, failed to be significant $t(68) = 1.780$, $p = 0.080$, Cohen's $d = 0.58$, whereas in the presence of seductive details, the difference between the animated and static formats was significant and in favour of the animated format, $t(68) = 3.109$, $p = 0.003$, Cohen's $d = 1.07$.

3.2.2 | Time spent on task

Similar to the results obtained regarding children's achievement in the paper-folding task, analyses revealed a significant main effect for the type of illustrations on time spent on task, $F(1, 68) = 27.732$, $p < 0.001$, $\eta^2 = 0.286$. In accordance with H2a, the results revealed

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Mean percentages (and standard deviations) for outcome variables by group for Experiment 2.

	Without seductive details		With seductive details	
	Static illustrations (n = 19)	Animated illustrations (n = 19)	Static illustrations (n = 19)	Animated illustrations (n = 15)
% of steps correctly achieved	70.7 (33.4)	88.7 (27.9)	59.8 (41.2)	93.3 (11.3)
Time spent on task (min.)	14.1 (4.87)	8.44 (3.44)	14.5 (4.98)	9.83 (2.31)
Situational interest / 5	4.68 (0.48)	4.68 (0.67)	4.26 (1.19)	4.13 (1.19)
Cognitive load / 5	2.63 (1.50)	2.42 (1.17)	3.05 (1.31)	2.13 (1.46)

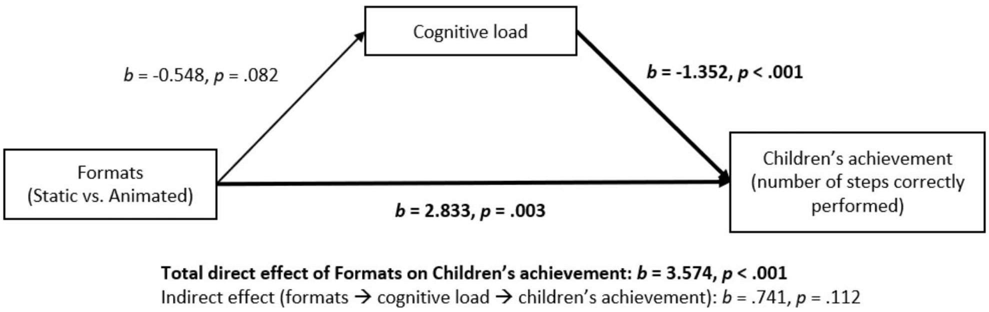

FIGURE 3 Mediation analysis results testing if the cognitive load functions as a mediator of the animated effect in Experiment 2.

that children viewing animated illustrations spent a lower amount of time on task as compared to those viewing static illustrations (9.05 min vs. 14.3 min, on average, respectively). No significant main effect for seductive details was observed, $F(1, 68) = 0.835$, $p = 0.364$, $\eta^2 = 0.009$ (infirming H2b). The ANOVA also indicated that there was no significant interaction effect between the two independent variables on time spent on task, $F(1, 68) = 0.262$, $p = 0.611$, $\eta^2 = 0.003$ (contradicting H2c).

3.2.3 | Situational interest

The ANOVA showed a significant main effect for seductive details, $F(1, 68) = 4.964$, $p = 0.029$, $\eta^2 = 0.068$, but no significant main effect for the type of illustration, $F(1, 68) = 0.089$, $p = 0.767$, $\eta^2 = 0.001$. In addition, the interaction between the type of illustrations and the presence of seductive details was not significant, $F(1, 68) = 0.089$, $p = 0.767$, $\eta^2 = 0.001$. The results revealed that viewing printed design paper (static or animated) decreased students' interest in the task ($M = 4.68$ in both groups without seductive details vs. $M = 4.21$ in both groups with seductive details), which contradicts H3a.

3.2.4 | Cognitive load

The ANOVA revealed no main effect for the type of illustration children were provided with (static vs. animated) on their ratings of the cognitive load induced by the task, $F(1, 68) = 3.074$, $p = 0.084$, $\eta^2 = 0.043$ (H4). Moreover, no significant main effect for seductive details or interaction effect was obtained ($F(1, 68) = 0.043$, $p = 0.837$, $\eta^2 = 0.001$, and $F(1, 68) = 1.210$, $p = 0.275$, $\eta^2 = 0.017$, respectively). However, a univariate comparison between the animated and static presentation conditions in the presence of seductive details revealed a marginal effect that was almost significant, $t(68) = 1.957$, $p = 0.054$, Cohen's $d = 0.68$. This trend showed that, in the presence of seductive details, cognitive load was higher when the presentation was static.

As a complementary analysis, we performed a mediation analysis to see if the cognitive load functions as a mediator of the animated effect. Results revealed a direct effect of the Format used (static vs. animated) on children's performance ($b = 2.833$, $p = 0.003$) with no indirect effect when adding cognitive load as a mediator ($b = 0.741$, $p = 0.112$). Cognitive load as an effect on children's achievement: the more children perceived a high amount of cognitive load, the smaller number of steps they correctly achieved in the task ($r = -0.46$, $p < 0.001$). Figure 3 below shows the mediation model obtained following this analysis.

3.3 | Discussion of experiment 2

The results obtained in the second study were different from those of the first study. They revealed a positive effect for animations on children's performance: viewing animated illustrations significantly improved their achievement of the task and reduced the time spent on it. This is in line with previous research demonstrating the superiority of animations over static illustrations for learning (Berney & Bétrancourt, 2016; Ploetzner et al., 2020), including learning among young children. This is also in accordance with the fact that animations, as compared to their static counterparts, improve learning when the task is challenging (Lowe et al., 2022). Contrary to the first study and our expectations, no effects for seductive details on children's

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

performance were found. Surprisingly, the results even showed that seductive details reduced students' situational interest in the task even if students perceived situational interest was really high in the four conditions of the study (mean average above 4 out of a 5-point Likert scale). As all of the students were highly interested in the study, it was difficult to observe how seductive details really influenced children's interest. Moreover, the item used to measure situational interest only assessed students' overall interest in the activity but not their interest in the pedagogical material used to perform the hand-gesture task. Precise items asking learners what they thought about the seductive details should be assessed in future studies to see whether they found these elements interesting and entertaining. However, we found two coherent and converging, although not significant, trends: (i) seductive details tended to impair performance less strongly in the animated condition than in the static condition, and (ii) in the presence of seductive details, cognitive load seemed higher when the presentation was static than when it was dynamic.

4 | GENERAL DISCUSSION

In two experimental studies, the effects of illustration format (animated vs. static) combined with the presence or absence of seductive details in learning a hand-gesture procedure (origami) were investigated among young children in a naturalistic environment. We aimed to extend the current knowledge about the effects of illustration format (static vs. animated) on learning with younger children, as most previous studies have been conducted with university students. We also investigated how the presence of seductive details in the relevant area of a learning document influences learning when combined with various illustration types (animations or static illustrations). Children were asked to reproduce an origami while viewing one of four presentation formats for the paper-folding task: static illustrations without seductive details, static illustrations with seductive details (i.e., printed design paper), animated illustrations without seductive details, and animated illustrations with seductive details. Based on previous research, we expected positive effects for animation and negative effects for seductive details on children's performance (Boucheix & Forestier, 2017; Sundararajan & Adesope, 2020).

In the first experiment, conducted with children aged 5–6 years old and an eight-step origami task, a significant negative effect for seductive detail was found with very young children. This is in line with previous research, which has mainly been conducted with older participants, including adults. In contrast to the previous findings (Berney & Bétrancourt, 2016; Boucheix & Forestier, 2017; Lowe et al., 2022; Ploetzner et al., 2020), performance levels remained similar in the two presentation formats (static vs. animated). However, the results of this first experiment should be considered with caution because (i) a ceiling effect was observed (all performances reached 70% or more) due to the easiness of the task, which could have reduced the influence of the manipulated factors; (ii) there were sample size limitations ($n = 12$–13 for some groups); and (iii) there were also methodological issues related to discrepancies in the design of the information presentation between the four conditions.

In Experiment 2, we endeavoured to overcome these limitations by using a more complex and challenging origami task with older children ($M = 8.01$ years old), increasing the sample size, and equalizing the design of the information presentation across the conditions, except for the tested factors (format and seductive details), that is, with all other things being equal. The results were different from but coherent with those of the first study. Learning performance levels were higher in the dynamic presentation format than in the static counterpart, whereas there was no influence on the part of seductive details. We propose the involvement of two types of cognitive mechanisms as hypotheses to explain the results of Experiments 1 and 2, as well as their coherence despite the differences in the results.

The children in the first experiment were much younger (5.6) than those in the second experiment (8.01). It may be that older children were disturbed by the presence of seductive details when viewing the document (thus the negative effects on their interest) but managed to inhibit this information. Indeed, seductive details could be disturbing or not depending on students' ability to control their attention and inhibit irrelevant information. As children's control and inhibition abilities develops with age, it may be that the younger children from the first study had more difficulty inhibiting irrelevant information as compared to the older children who participated in the second study. This is in line with the Wang and Adesope's (Wang & Adesope, 2016, p. 75) conclusion that, "Given cognitive maturation and increased learning experience, it is possible that college students might be better able to differentiate the irrelevant information from the main content and thus would be less distracted by seductive details." Also, following Eitel et al. (2020), we could hypothesize that the older children exerted more control of their cognitive processing and self-managed the cognitive load induced by the learning situation better, this would also explain why cognitive load was not a significant mediator of the format used on children's performance. In sum, regarding the implication of our results for cognitive theory of seductive details, our results are consistent with the coherence principle of the CTML (see, Fiorella & Mayer, 2021, pp. 187–189). Furthermore, to some extent, the processing of seductive details while learning from a multimedia document could be compared to the processing mechanism involved in a series of research about the effect of interruption during reading and comprehension tasks. Such interruptions usually require leaving the current reading task to process information that is not coherent with what was previously read and then coming back to the main text. The research in this field shows that for teenagers, as well as for adults, interruptions have no significant effect on comprehension of the main textual information (see Chevet, Baccino, Marlot, et al., 2022 and Chevet, Baccino, Vinter, et al., 2022).

However, a closer look at the results of Experiment 2 indicated that a more negative influence on the part of the presence of seductive details appeared for learners in the static format presentation as compared to learners in the animated presentation format. Why was this true? One potential explanation is related to learners' attention dynamics when processing animated information, especially human movements and hand motions. Dynamic information and movement more strongly attract the attention of human beings than static

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

information and even seductive details (Wolfe & Horowitz, 2004). In the animated presentation, learners' attention could have been primarily focused on the movements of the paper folding, as well as the movements of the hands, which are not only perceptually salient but also relevant to learning an origami procedure. In this case, there is a good alignment between perceptual salience and thematic relevance (Lowe et al., 2022; Lowe & Boucheix, 2016). In consequence, less attention is paid to seductive details because the movement wins the competition with the other presented information. In the static format, there are no contrasting movements, and the dynamics must be inferred from static representations of the steps of the procedure. In consequence, seductive details may become more salient than the steps of the procedure. This suggested explanation fits perfectly with the models and theory about animation processing in multimedia documents. Firstly, the meta-analyses evoked above indicate that animations are superior to static presentation for procedural learning (Berney & Bétrancourt, 2016; Castro-Alonso et al., 2019; Höffler & Leutner, 2007; Ploetzner et al., 2020), especially for human hand manipulation. Secondly, the models (see e.g., Lowe & Boucheix, 2008, 2016) propose that dynamic information salience and transience effects attract human attention, and more than their static counterparts. Further, according to the "attentional theory of cinematic continuity"—AToCC, Smith, 2012; Smith et al., 2012), the temporal continuity of videos may help maintain attentional focus on task relevant information and then improve the memorization of continuous events display, especially hand procedures, whereas, series of static pictures could break, or disturb, attention continuity. Consequently, in the latter case, seductive details are more likely to attract the learner's attention and then disrupt learning.

In the two present experiments we chose illustrations that were irrelevant for the achievement of the learning goal which meets the definition of seductive details (Rey, 2012). Moreover, we followed the experimental design of previous studies which used irrelevant images to investigate the effects of seductive pictures (e.g., Harp & Mayer, 1998; Magner et al., 2014; Rey, 2011, 2014; Sanchez & Wiley, 2006). Just as in Magner et al.'s study (Magner et al., 2014) the illustrations we chose here only had a decorative function and could induced unnecessary processing demands. However, we cannot be certain that children found the seductive details used in study 1 and 2 interesting. Therefore, a manipulation check should be done to make sure that seductive details were considered interesting by learners.

5 | CONCLUSION

Given the results, future studies should measure children's inhibition abilities, as this could influence the impact seductive details have on children's performance and check if the illustrations actually triggered learners' situational interest. More specifically, future research should investigate whether the negative effects of seductive details appear only when children's inhibition abilities are low. Combining inhibition ability measures with eye-tracking outcomes could also be a relevant way to pursue this study, as one could hypothesize that students' inhibition abilities influence the way they process information. Eye-tracking measures could also reveal how learners process seductive details: do they grab their attention? If so, how much time? and so on. Moreover, measuring the different aspects of cognitive load (i.e., intrinsic, extraneous, and germane) based on recent developed instruments such as the Cognitive Load Questionnaire developed by Klepsch et al. (2017) could provide more insight of the effects of seductive details and animations illustrations on students' information processing. In the present experiment, we did not distinguish between the different kinds of cognitive load. Doing so could have revealed a mediation effect of one specific type of cognitive load on children's learning performance. One could expect the intrinsic cognitive load to be higher in the static illustrations conditions as children need to infer the dynamics of the procedure and to negatively influence students' learning. The subjective rating item used in the present study may have not been reliable especially with young children. Measuring precisely and objectively the intrinsic cognitive load induced by the illustrations format (static vs. animated) by using pupil dilation for example could reveal a mediation effect of cognitive load on children's achievement. Finally, children's performance should be assessed immediately after they view the learning document, as well as several weeks later. Indeed, additional research projects should investigate the effects of presentation formats on long-term learning with delayed tests to determine whether the results observed persist over time.

AUTHOR CONTRIBUTIONS

Tiphaine COLLIOT: Conceptualization; investigation; methodology; supervision; writing – original draft; writing – review and editing. **Jean-Michel Boucheix:** Conceptualization; methodology; writing – original draft; writing – review and editing.

ACKNOWLEDGEMENTS

We would like to thank Naëlle Chabot, Marie Le Neuresse and Louise Ragueneau for their work on this research. These students collected and coded the data of this research.

FUNDING INFORMATION

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/jcal.12879.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

ORCID

Tiphaine Colliot https://orcid.org/0000-0001-9843-0014

Jean-Michel Boucheix https://orcid.org/0000-0003-0830-0609

REFERENCES

Alemdag, E., & Cagiltay, K. (2018). A systematic review of eye tracking research on multimedia learning. *Computers & Education*, *125*, 413–428. https://doi.org/10.1016/j.compedu.2018.06.023

Arguel, A., & Jamet, E. (2009). Using video and static pictures to improve learning of procedural contents. *Computers in Human Behavior*, *25*(2), 354–359. https://doi.org/10.1016/j.chb.2008.12.014

Atkinson, R. K., Renkl, A., & Merrill, M. M. (2003). Transitioning from studying examples to solving problems: Effects of self-explanation prompts and fading worked-out steps. *Journal of Educational Psychology*, *95*(4), 774–783. https://doi.org/10.1037/0022-0663.95.4.774

Ayres, P., Marcus, N., Chan, C., & Qian, N. (2009). Learning hand manipulative tasks: When instructional animations are superior to equivalent static representations. *Computers in Human Behavior*, *25*(2), 348–353. https://doi.org/10.1016/j.chb.2008.12.013

Barrouillet, P., Bernardin, S., Portrat, S., Vergauwe, E., & Camos, V. (2007). Time and cognitive load in working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(3), 570–585. https://doi.org/10.1037/0278-7393.33.3.570

Bender, L., Renkl, A., & Eitel, A. (2021a). Seductive details do their damage also in longer learning sessions–when the details are perceived as relevant. *Journal of Computer Assisted Learning*, *37*(5), 1248–1262. https://doi.org/10.1111/jcal.12560

Bender, L., Renkl, A., & Eitel, A. (2021b). When and how seductive details harm learning. A study using cued retrospective reporting. *Applied Cognitive Psychology*, *35*(4), 948–959. https://doi.org/10.1002/acp.3822

Berney, S., & Bétrancourt, M. (2016). Does animation enhance learning? A meta-analysis. *Computers & Education*, *101*, 150–167. https://doi.org/10.1016/j.compedu.2016.06.005

Bétrancourt, M. (2005). The animation and interactivity principles in multimedia learning. In R. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 287–296). Cambridge University Press. https://doi.org/10.1017/CBO9780511816819.019

Bétrancourt, M., & Tversky, B. (2000). Effects of computer animation on users' performance: A review. *Le Travail Humain*, *63*, 311–329.

Boucheix, J. M., & Forestier, C. (2017). Reducing the transience effect of animations does not (always) lead to better performance in children learning a complex hand procedure. *Computers in Human Behavior*, *69*, 358–370. https://doi.org/10.1016/j.chb.2016.12.029

Boucheix, J. M., & Guignard, H. (2005). What animated illustrations conditions can improve technical document comprehension in young students? Format, signaling and control of the presentation. *European Journal of Psychology of Education*, *20*(4), 369–388. https://doi.org/10.1007/BF03173563

Boucheix, J. M., & Schneider, E. (2009). Static and animated presentations in learning dynamic mechanical systems. *Learning and Instruction*, *19*(2), 112–127. https://doi.org/10.1016/j.learninstruc.2008.03.004

Brucker, B., Ehlis, A. C., Häußinger, F. B., Fallgatter, A. J., & Gerjets, P. (2015). Watching corresponding gestures facilitates learning with animations by activating human mirror-neurons: An fNIRS study. *Learning and Instruction*, *36*, 27–37. https://doi.org/10.1016/j.learninstruc.2014.11.003

Castro-Alonso, J., Wong, M., Adesope, O. O., Ayres, P., & Paas, F. (2019). Gender imbalance in instructional dynamic versus static visualizations: A meta-analysis. *Educational Psychology Review*, *31*(2), 361–387. https://doi.org/10.1007/s10648-019-09469-1

Chevet, G., Baccino, T., Marlot, L., Vinter, A., & Drai-Zerbib, V. (2022). Effects of interruption on eye movements and comprehension during reading on digital devices. *Learning and Instruction*, *80*, 101565. https://doi.org/10.1016/j.learninstruc.2021.101565

Chevet, G., Baccino, T., Vinter, A., & Drai-Zerbib, V. (2022). What breaks the flow of reading? A study on characteristics of attentional disruption during digital reading. *Frontiers in Psychology*, *13*, 987964. https://doi.org/10.3389/fpsyg.2022.987964

Cook, S. W., Friedman, H. S., Duggan, K. A., Cui, J., & Popescu, V. (2017). Hand gesture and mathematics learning: Lessons from an avatar. *Cognitive Science*, *41*(2), 518–535. https://doi.org/10.1111/cogs.12344

DeLeeuw, K. E., & Mayer, R. E. (2008). A comparison of three measures of cognitive load: Evidence for separable measures of intrinsic, extraneous, and germane load. *Journal of Educational Psychology*, *100*(1), 223–234. https://doi.org/10.1037/0022-0663.100.1.223

Delgado, P., & Salmerón, L. (2022). Cognitive effort in text processing and reading comprehension in print and on tablet: An eye-tracking study. *Discourse Processes*, *59*(4), 237–274. https://doi.org/10.1080/0163853X.2022.2030157

Eitel, A., Bender, L., & Renkl, A. (2018). Are seductive details seductive only when you think they are relevant? An experimental test of the moderating role of perceived relevance. *Applied Cognitive Psychology*, *33*(1), 20–30. https://doi.org/10.1002/acp.3479

Eitel, A., Endres, T., & Renkl, A. (2020). Self-management as a bridge between cognitive load and self-regulated learning: The illustrative case of seductive details. *Educational Psychology Review*, *32*(4), 1073–1087. https://doi.org/10.1007/s10648-020-09559-5

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175–191. https://doi.org/10.3758/BF03193146

Fiorella, L., & Mayer, R. E. (2021). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. In R. Mayer & L. Fiorella (Eds.), *The cambridge handbook of multimedia learning* (3rd ed., pp. 185–198). Cambridge University Press. https://doi.org/10.1017/9781108894333.019

Frechette, C., & Moreno, R. (2010). The roles of animated pedagogical agents' presence and nonverbal communication in multimedia learning environments. *Journal of Media Psychology: Theories, Methods, and Applications*, *22*(2), 61–72. https://doi.org/10.1027/1864-1105/a000009

Fries, L., DeCaro, M. S., & Ramirez, G. (2019). The lure of seductive details during lecture learning. *Journal of Educational Psychology*, *111*(4), 736–749. https://doi.org/10.1037/edu0000301

Ganier, F., & de Vries, P. (2016). Are instructions in video format always better than photographs when learning manual techniques? The case of learning how to do sutures. *Learning and Instruction*, *44*, 87–96. https://doi.org/10.1016/j.learninstruc.2016.03.004

Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology*, *90*, 414–434. https://doi.org/10.1037/0022-0663.90.3.414

Hegarty, M., Kriz, S., & Cate, C. (2003). The roles of mental animations and external animations in understanding mechanical systems. *Cognition and Instruction*, *21*(4), 209–249. https://doi.org/10.1207/s1532690xci2104_1

Höffler, T. N., & Leutner, D. (2007). Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction*, *17*(6), 722–738. https://doi.org/10.1016/j.learninstruc.2007.09.013

Jiang, D., & Sweller, J. (2022). The transient information principle in multimedia learning. In L. Fiorella & R. E. Mayer (Eds.), *The Cambridge handbook of multimedia learning* (3rd ed., pp. 268–274). Cambridge University Press. https://doi.org10.1017/9781108894333.027

Ketzer-Nöltge, A., Schweppe, J., & Rummer, R. (2018). Is the seductive details effect moderated by mood? An eye-tracking study. *Applied Cognitive Psychology*, *33*(1), 62–70. https://doi.org/10.1002/acp.3487

Klepsch, M., Schmitz, F., & Seufert, T. (2017). Development and validation of two instruments measuring intrinsic, extraneous, and germane

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

cognitive load. *Frontiers in Psychology*, *8*, 1997. https://doi.org/10.3389/fpsyg.2017.01997

Korbach, A., Brünken, R., & Park, B. (2016). Learner characteristics and information processing in multimedia learning: A moderated mediation of the seductive details effect. *Learning and Individual Differences*, *51*, 59–68. https://doi.org/10.1016/j.lindif.2016.08.030

Leahy, W., & Sweller, J. (2011). Cognitive load theory, modality of presentation and the transient information effect. *Applied Cognitive Psychology*, *25*(6), 943–951. https://doi.org/10.1002/acp.1787

Lehmann, J. A. M., Hamm, V., & Seufert, T. (2019). The influence of background music on learners with varying extraversion: Seductive detail or beneficial effect? *Applied Cognitive Psychology*, *33*(1), 85–94. https://doi.org/10.1002/acp.3509

Lowe, R., & Boucheix, J. M. (2011). Cueing complex animations: Does direction of attention foster learning processes? *Learning and Instruction*, *21*(5), 650–663. https://doi.org/10.1016/j.learninstruc.2011.02.002

Lowe, R. K. (1999). Extracting information from an animation during complex visual learning. *European Journal of Psychology of Education*, *14*, 225–244. https://doi.org/10.1007/BF03172967

Lowe, R. K., & Boucheix, J. M. (2008). Learning from animated diagrams: How are mental models built? In G. Stapleton, J. Howse, & J. Lee (Eds.), *Theory and applications of diagrams* (pp. 266–281). Springer.

Lowe, R. K., & Boucheix, J. M. (2016). Principled animation design improves comprehension of complex dynamics. *Learning and Instruction*, *45*, 72–84. https://doi.org/10.1016/j.learninstruc.2016.06.005

Lowe, R. K., Schnotz, W., & Boucheix, J. M. (2022). The animation composition principle in multimedia learning. In R. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (3rd ed., pp. 313–323). Cambridge University Press. https://doi.org/10.1017/9781108894333.033

Magner, U. I., Schwonke, R., Aleven, V., Popescu, O., & Renkl, A. (2014). Triggering situational interest by decorative illustrations both fosters and hinders learning in computer-based learning environments. *Learning and Instruction*, *29*, 141–152. https://doi.org/10.1016/j.learninstruc.2012.07.002

Marcus, N., Cleary, B., Wong, A., & Ayres, P. (2013). Should hand actions be observed when learning hand motor skills from instructional animations? *Computers in Human Behavior*, *29*(6), 2172–2178. https://doi.org/10.1016/j.chb.2013.04.035

Mayer, R. E. (2014a). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed., pp. 43–71). Cambridge University Press. https://doi.org/10.1017/CBO9781139547369.005

Mayer, R. E. (2014b). Incorporating motivation into multimedia learning. *Learning and Instruction*, *24*, 171–173. https://doi.org/10.1016/j.learninstruc.2013.04.003

Mayer, R. E., DeLeeuw, K. E., & Ayres, P. (2007). Creating retroactive and proactive interference in multimedia learning. *Applied Cognitive Psychology*, *21*(6), 795–809. https://doi.org/10.1002/acp.1350

Mayer, R., & Fiorella, L. (2021). *The cambridge handbook of multimedia learning* (3rd ed.). Cambridge University Press. https://doi.org/10.1017/9781108894333

Moreno, R. (2006). Does the modality principle hold for different media? A test of the method-affects learning hypothesis. *Journal of Computer Assisted Learning*, *22*(3), 149–158. https://doi.org/10.1111/j.1365-2729.2006.00170.x

Moreno, R. (2009). Learning from animated classroom exemplars: The case for guiding student teachers' observations with metacognitive prompts. *Educational Research and Evaluation*, *15*(5), 487–501. https://doi.org/10.1080/13803610903444592

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments special issue on interactive learning environments: Contemporary issues and trends. *Educational Psychology Review*, *19*(3), 309–326. https://doi.org/10.1007/s10648-007-9047-2

Moreno, R., & Valdez, A. (2005). Cognitive load and learning effects of having students organize pictures and words in multimedia environments: The role of student interactivity and feedback. *Educational Technology Research and Development*, *53*(3), 35–45. https://doi.org/10.1007/BF02504796

Noetel, M., Griffith, S., Delaney, O., Harris, N. R., Sanders, T., Parker, P., del Pozo Cruz, B., & Lonsdale, C. (2022). Multimedia design for learning: An overview of reviews with meta-meta-analysis. *Review of Educational Research*, *92*(3), 413–454. https://doi.org/10.3102/00346543211052329

Paas, F., & Sweller, J. (2014). Implication of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (2nd ed., pp. 27–42). Cambridge University Press. https://doi.org/10.1017/CBO9781139547369.005

Park, B., Korbach, A., & Brünken, R. (2015). Do learner characteristics moderate the seductive-details-effect? A cognitive-load-study using eye-tracking. *Journal of Educational Technology & Society*, *18*(4), 24–36.

Park, B., Korbach, A., & Brünken, R. (2020). Does thinking-aloud affect learning, visual information processing and cognitive load when learning with seductive details as expected from self-regulation perspective? *Computers in Human Behavior*, *111*, 106411. https://doi.org/10.1016/j.chb.2020.106411

Park, B., Moreno, R., Seufert, T., & Brünken, R. (2011). Does cognitive load moderate the seductive details effect? A multimedia study. *Computers in Human Behavior*, *27*(1), 5–10. https://doi.org/10.1016/j.chb.2010.05.006

Ploetzner, R., Berney, S., & Bétrancourt, M. (2020). A review of learning demands in instructional animations: The educational effectiveness of animations unfolds if the features of change need to be learned. *Journal of Computer Assisted Learning*, *36*(6), 838–860. https://doi.org/10.1111/jcal.12476

Post, L. S., Van Gog, T., Paas, F., & Zwaan, R. A. (2013). Effects of simultaneously observing and making gestures while studying grammar animations on cognitive load and learning. *Computers in Human Behavior*, *29*(4), 1450–1455. https://doi.org/10.1016/j.chb.2013.01.005

R Core Team. (2018). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna. https://www.R-project.org

Rey, G. D. (2011). Seductive details in multimedia messages. *Journal of Educational Multimedia and Hypermedia*, *20*, 61–92.

Rey, G. D. (2012). A review of research and a meta-analysis of the seductive detail effect. *Educational Research Review*, *7*, 216–237. https://doi.org/10.1016/j.edurev.2012.05.003

Rey, G. D. (2014). Seductive details and attention distraction–an eye tracker experiment. *Computers in Human Behavior*, *32*, 133–144. https://doi.org/10.1016/j.chb.2013.11.017

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience*, *27*, 169–192. https://doi.org/10.1146/annurev.neuro.27.070203.144230

Rotgans, J. I., & Schmidt, H. G. (2014). Situational interest and learning: Thirst for knowledge. *Learning and Instruction*, *32*, 37–50. https://doi.org/10.1016/j.learninstruc.2014.01.002

Salmerón, L., Delgado, P., Vargas, C., & Gil, L. (2021). Tablets for all? Testing the screen inferiority effect with upper primary school students. *Learning and Individual Differences*, *86*, 101975. https://doi.org/10.1016/j.lindif.2021.101975

Sanchez, C. A., & Wiley, J. (2006). An examination of the seductive details effect in terms of working memory capacity. *Memory & Cognition*, *34*(2), 344–355. https://doi.org/10.3758/BF03193412

Schneider, S., Beege, M., Nebel, S., Schnaubert, L., & Rey, G. D. (2021). The cognitive-affective-social theory of learning in digital environments (CASTLE). *Educational Psychology Review*, *34*, 1–38. https://doi.org/10.1007/s10648-021-09626-5

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Schwan, S., & Riempp, R. (2004). The cognitive benefits of interactive videos: Learning to tie nautical knots. *Learning and Instruction*, *14*, 293–305. https://doi.org/10.1016/j.learninstruc.2004.06.005

Smith, T. J. (2012). The attentional theory of cinematic continuity. *Projections: The Journal for Movies and the Mind*, *6*(1), 1–27. https://doi.org/10.3167/proj.2012.060102

Smith, T. J., Levin, D., & Cutting, J. E. (2012). A window on reality: Perceiving edited moving images. *Current Directions in Psychological Science*, *21*(2), 107–113. https://doi.org/10.1177/096372141243740

Spanjers, I. A., Wouters, P., Van Gog, T., & Van Merrienboer, J. J. (2011). An expertise reversal effect of segmentation in learning from animated worked-out examples. *Computers in Human Behavior*, *27*(1), 46–52. https://doi.org/10.1016/j.chb.2010.05.011

Sundararajan, N., & Adesope, O. (2020). Keep it coherent: A meta-analysis of the seductive details effect. *Educational Psychology Review*, *32*(3), 707–734. https://doi.org/10.1007/s10648-020-09522-4

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory*. Springer.

Sweller, J., van Merriënboer, J. J., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. *Educational Psychology Review*, *31*(2), 261–292. https://doi.org/10.1007/s10648-019-09465-5

The jamovi project. (2019). *jamovi. (Version 1.1)* [Computer Software]. Retrieved from https://www.jamovi.org

Torkar, G. (2022). Interview with Richard E. Mayer about multimedia materials and textbooks. *Center for Educational Policy Studies Journal*, *12*(2), 189–195. https://doi.org/10.26529/cepsj.1238

Van Gog, T., Paas, F., Marcus, N., Ayres, P., & Sweller, J. (2009). The mirror neuron system and observational learning: Implications for the effectiveness of dynamic visualizations. *Educational Psychology Review*, *21*(1), 21–30. https://doi.org/10.1007/s10648-008-9094-3

Wang, Z., & Adesope, O. (2016). Exploring the effects of seductive details with the 4-phase model of interest. *Learning and Motivation*, *55*, 65–77. https://doi.org/10.1016/j.lmot.2016.06.003

Wang, Z., Ardasheva, Y., Carbonneau, K., & Liu, Q. (2021). Testing the seductive details effect: Does the format or the amount of seductive details matter? *Applied Cognitive Psychology*, *35*(3), 761–774. https://doi.org/10.1002/acp.3801

Wolfe, J. M., & Horowitz, T. S. (2004). What attributes guide the deployment of visual attention and how do they do it? *Nature Reviews Neuroscience*, *5*, 1–7. https://doi.org/10.1038/nrn1411

Wong, A., Leahy, W., Marcus, N., & Sweller, J. (2012). Cognitive load theory, the transient information effect and e-learning. *Learning and Instruction*, *22*(6), 449–457. https://doi.org/10.1016/j.learninstruc.2012.05.004

Wong, A., Marcus, N., Ayres, P., Smith, L., Cooper, G. A., Paas, F., & Sweller, J. (2009). Instructional animations can be superior to statics when learning human motor skills. *Computers in Human Behavior*, *25*(2), 339–347. https://doi.org/10.1016/j.chb.2008.12.012

How to cite this article: Colliot, T., & Boucheix, J.-M. (2024). Exploring the effects of seductive details and illustration dynamics on young children's performance in an origami task. *Journal of Computer Assisted Learning*, *40*(2), 437–451. https://doi.org/10.1111/jcal.12879

13652729, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/jcal.12879 by Cochrane France, Wiley Online Library on [13/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License