Do learners make more pauses in instructional videos when taking notes?

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Abstract

This study aimed to test the benefit of note-taking on pauses and learning in online educational videos. Participants ($N = 72$) were randomly assigned to one of two note-taking conditions (allowed or not) with the possibility to take pauses during a 10-minute online instructional video on the autonomic nervous system. The results did not reveal a significant correlation between note-taking and the number of pauses. Moreover, we observed no significant effect of note-taking on learning performance. However, prior knowledge and age affected significantly the relationship between pauses, note-taking and learning performance. We discuss the importance of prior knowledge and age for future research.

Keywords: Pauses; Note-taking; Learning; Instructional videos

Introduction

Video learning

Instructional videos, defined as "video lesson that is intended to help people learn targeted material" (Fiorella & Mayer, 2018), are commonly used in online platforms in a learning context and have given rise to research in the literature (see Mayer, 2021). Instructional videos generally present information in auditory and visual channels from technologies taking different forms (e.g., Massive Open Online Courses, MOOC) and applying to different educational contexts.

Videos have some benefits compared to more traditional written pedagogical contents. According to dual-coding processing theory (Paivio, 1990) and Cognitive Theory of Multimedia Learning (Mayer, 2014; Mayer, 2020), which both rely on Working Memory (WM, i.e., the capacity to temporarily stock and manipulate information with a limited capacity), learning is improved when it involves a double coding with verbal and non-verbal channels, but also with auditory and visual channels. Pedagogical videos often match these characteristics (Cojean & Martin, 2021).

However, videos provide transient information consuming limited cognitive resources of learners (Mayer & Pilegard, 2014; Merkt et al., 2018). Transience requires maintaining preceding information and integrating it with incoming information (Merkt et al 2011). Hence, learning from instructional videos requires continuous integration of incoming transient information in WM and can overwhelm the limits of WM, restraining the transfer of critical information to long-term memory.

The importance of pauses

Several studies considered the pacing principle by adding pauses to reduce extraneous cognitive load induced by transience (Mayer & Pilegard, 2014; Merkt et al., 2018; Lee et al., 2020). As both storage and processing of information share attentional resources and have to alternate (Barrouillet et al., 2004), pauses are the opportunity to stop processing new information and to focus on maintenance.

Pauses can be learner-determined or system-determined (Hasler et al., 2007; Merkt et al., 2018). Biard et al. (2018) tested the effect of a 5-minute instructional video on learning in which students were divided into three groups: noninteractive video, video with learner-paced control and video with system-paced pauses. Their results showed that including the possibility of pacing can benefit learners, but only in the condition where pauses were system-determined. Results also showed that learners take few pauses by themselves. In this study, learners did less than 3 free pauses, while the system-paced condition imposed 24 pauses. In the study of Cojean and Jamet (2022), 29,82% of learners take pauses at least once (mean of 1,53 pauses) within a video of 18 min.

An explanation could be related to the expertise level (Wouters et al., 2007) because novices don't know when to take pauses, and guiding on how to take pauses seems to improve learning and encourage learners to take pauses (Lin et al., 2022). Other works showed that pauses increased with perceived difficulties in comprehension and meaningful structural breakpoints in the videos (Merkt et al., 2022). In this line, Lee et al. (2020) tested the pausing effect on cognitive load and performance in a medical context, arguing that pauses were voluntary actions in intense situations. Their results showed that the availability of pauses increased both cognitive load (by cognitive stimulating and meta-cognitive processes) and performance but that the act of pausing finally lowered cognitive load during intense moments (through relaxation).

In most of the studies about video learning and the effects of pauses (e.g., Fyfield et al., 2022), note-taking is not allowed. Some critics already questioned the ecologic validity of the used material. Fyfield et al. (2022) suggested that participants were passive in studies during the presentation of instructional videos, while most people are

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likely to take notes during a lecture (Peverly & Wolf, 2019; Morehead et al., 2019). In particular, the question arises as to whether the pausing behaviors observed in studies without note-taking can be generalized to natural situations (i.e., with possible note-taking).

Note-taking in videos

Anyone who has taught can attest that most students take notes during lessons. Note-taking during lectures is omnipresent, with 95% of students reporting that they take notes when attending a lecture (Peverly & Wolf, 2019). Note-taking serves two main functions, encoding and external storage (Di Vesta and Gray, 1972; Jansen, 2017; Kiewra, 1989; Morehead et al., 2019). Encoding is the way that note-taking directly improve learning processes by facilitating retention in long-term memory, and storage is the way that notes are learned later and the effects on a delayed learning test (Di Vesta & Gray, 1972; Kobayashi, 2006; Morehead et al., 2019).

Previous literature on note-taking showed inconstantly results about the superiority of longhand or laptop method (e.g., Morehead et al., 2019; Urry et al., 2020). Overall, what seems the most important is not the note-taking method (i.e., longhand or laptop), but rather strategies of note-taking. Transcription of verbatim is associated with poorer learning, while reformulations seem to be the best way to take relevant notes (Mueller & Oppenheimer, 2014; Urry et al., 2021; Wilson et al., 2023).

Note-taking strongly rely on WM, as learners have to switch between understanding the course content and the production of notes (Friedman, 2014). If the choice is made to understand to the detriment of taking notes, learners will have a good performance on immediate learning test but no notes to review later. Video learning has an advantage compared to traditional in-class lectures: the possibility of making pauses. Pauses should be the opportunity to stop having to understand new information and to focus on efficient note production (i.e., reformulation).

Current study hypotheses

Both note-taking and video learning strongly solicit resources in WM (Friedman, 2014; Mayer, & Moreno, 2003). Due to the transitory aspect of video, video learners are required to maintain previously presented information while processing new information, which implies a high cognitive load (Merkt et al 2018). One solution in the context of learning videos might be to allow participants to take pauses to reduce the cost in WM due to information encoding (Merkt et al., 2018; Lee et al., 2020).

Previous work showed that learners are not likely to make pauses when available, but critics highlighted the lack of ecological studies (i.e., note-taking is banned during learning in most studies). Most learners take notes when learning (Peverly & Wolf, 2019; Morehead et al., 2019), and pauses may be particularly used and useful. Note-taking requires the division of attention during dual tasking (production and understanding), and pauses can be beneficial with extra time for cognitive processes by stopping the process of new information and focusing on maintenance in WM (Spanjers et al., 2012) or note production.

The main hypothesis of the current study is that, when note-taking is authorized, learners will make more pauses by themselves than when note-taking is banned. Indeed, it is hypothesized that learners make more pauses by themselves when they take notes because they would be more aware of the necessity to switch between understanding and note production than the necessity to switch between processing and maintenance.

In this perspective, our research question is whether the possibility of note-taking impact pauses behaviors. We expect more pauses (Hypothesis 1) and better learning (recall and comprehension, Hypothesis 2) for learners who can take notes compared to learners who can't.

Method

Participants

Seventy-two participants (mean age = 30.9, *SD* = 8.79) took part in the study (51% women), which was presented as a research project on instructional videos. Participants were recruited through the Prolific© platform and received £0.20 for their participation (only participants with 95 % approval rate participated in the study).

Material

Video. The video was created by the research team and focused on a biological course covering the human nervous system. The duration of the video was 592 seconds. The biology topic consisted of 9 slides, between 128 and 152 words per minute (total of 1312 words). The video included 3 slides with images (average of 148 words), 3 with text (average of 143 words), and 3 mixed with both text and images (average of 145 words).

The material was pre-tested on a small sample of participants (*N* = 15) in which they watched the video while taking notes on a computer with the possibility to take pauses. They then responded to questions about the video's content, rating difficulty, credibility, satisfactory, professionalism and motivation about the video content using a 7-point Likert scale (1 = "strongly disagree" to 7 = "strongly agree"). The instructional video was perceived as professional (*M* = 5.82), credible (*M* = 6.47), satisfactory (*M* = 4.80) and to a lesser extent difficult (*M* = 4.52) and motivating (*M* = 3.67).

Control variables. Note-taking habits when using a computer, learners' habits related to using instructional videos, prior knowledge, distraction, motivation and professionalism were evaluated using a 7-point Likert scale. Moreover, an item was used to determine whether participants had taken notes or not during the video.

Learning questionnaire. The evaluation of learning performance included 6 multiple choice questions (e.g., "What role does the vagus nerve play in controlling cardiac function?") with 2 comprehension questions (e.g., "Explain how the central nervous system and the peripheral nervous system process a nervous message in the example where a person sees a snake and moves backward") and 4 factual (i.e., memorization, e.g., "What is the composition of the central nervous system?") questions. Additionally, data related to note-taking and pauses were recorded using the Pavlovia platform (https://pavlovia.org). The video presentation, note-taking, and pause recordings were coded in JavaScript and with the jsPsych library (de Leeuw, 2015).

Procedure

Participants were instructed to watch an instructional video in a learning context. They were randomly assigned to one of the conditions: note-taking allowed or not (Figure 1). Participants had a space to the right of the video to take notes in the "note-taking allowed" condition. The video started after participants pressed the play button. Participants had control over the video using a "pause" button, allowing them to stop and restart the video, but they did not have the option to rewind or fast forward. A questionnaire started after the video finished. Instructions and questionnaires were presented through Qualtrics©, while the video presentation and data recording regarding note-taking and pauses were made with JavaScript code and from the Pavlovia© platform.

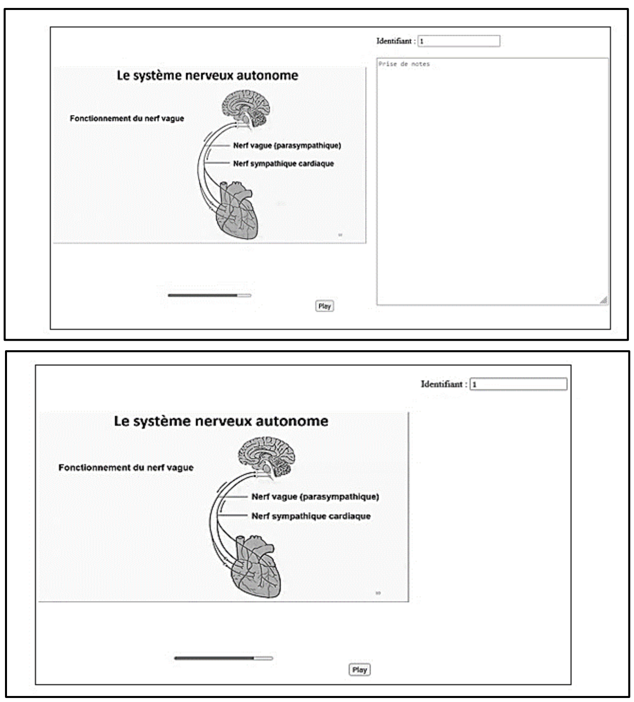

Figure 1: The conditions tested in the study: video with note-taking allowed (top) or not (down).

Results

One participant had technical problems while watching the video and 5 admitted to take notes in the "note-taking not allowed" condition. These participants were deleted from the analyses. Analyses were performed on a sample of 66 participants, 36 in the "note-taking allowed" condition and 30 in the "note-taking not allowed" condition.

The distribution of pauses number according to note-taking conditions is presented in Table 1. Most of the participants took no pause, 66.66% in the "note-taking allowed" condition and 70% in the "note-taking not allowed" condition took no pause. The total number of pauses ranges between 1 and more than 5 in both conditions. In H1, we expected more pauses from learners who can take notes compared to learners who can't. However, there was no significant difference between "note-taking allowed" and "note-taking not allowed" conditions on the pauses number, $t(64) = -1.24$, $p = .219$. Moreover, results showed no correlation between number of words taken in notes and pauses number ($r = .13$, $p = .277$).

Table 1: Distributions of number of pauses according to note-taking conditions.

	Participant (%)	
Pause number	Note-taking allowed	Note-taking not allowed
0	24 (66.66)	21 (70)
1	3 (8.33)	8 (26.66)
2	6 (16.66)	0 (0.0)
3	1 (2.77)	0 (0.0)
4	0 (0.0)	0 (0.0)
5	1 (2.77)	1 (2.77)
More than 5	1 (2.77)	0 (0.0)
Sum	36 (100)	30 (100)

We also hypothesized that recall and comprehension should be better for learners who can take notes compared to learners who can't (H2). To test this hypothesis, we conducted ANCOVAs with pauses number (z-standardized) and note-taking as a between-subject factor (allowed/not allowed). We detected seven outliers with the cook's distance (five for the comprehension score and two for the recall score). These participants were discarded from the analysis. The normality was tested with the Shapiro-Wilk test and variances homogeneity was tested with a Levene test (ps > $.05$). We applied Bonferroni correction in post hoc comparisons. Moreover, we tested whether groups (note-taking allowed or not) differed according to control variables (age, learners' prior knowledge, note-taking habits and habits related to instructional videos, motivation, distraction and professionalism).

Control variables. Prior knowledge, motivation, professionalism, age, note-taking habits, distraction and habits related to instructional videos did not differ between groups. Given the effect of prior knowledge on learning in instructional videos (Merkt et al., 2018), we controlled whether they affected the relationship between conditions and learning outcomes. Moreover, our sample included various ages (M = 30.9; SD = 8.79; *min* = 21; *max* = 56), and, given that WM capacity decline within normal aging (e.g., Mattay et al., 2006; Wang et al., 2011), we can suppose strategies of pauses or note-taking could be different according to age. To control these potential effects, we added these two variables (prior knowledge and age) as continuous covariates by including all interactions in tested models (Yzerbyt et al., 2004).

Main analyses. For the recall score, results did not show a significant effect of note-taking (p = .536) or a significant main effect of pauses (p = .481). Moreover, the interaction between pauses and note-taking on recall was not significant, $F(1, 48) = 0.14$, $p = .707$. For the comprehension score, results did not show a significant effect of note-taking (p = .560) or a significant main effect of pauses (p = .253). However, the interaction between pauses and note-taking on comprehension was significant, $F(1, 45) = 6.03$, $p =.018$. The decomposition of the interaction between pauses and note-taking indicated that comprehension was reduced when participants took pauses in the “note-taking not allowed” condition but this effect was not significant, $F(1, 45) = 4.01$, $p = .051$. Finally, the comprehension did not vary according to pauses in the “note-taking allowed” condition, $F(1, 45) = 2.28$, $p = .138$.

Exploratory analyses. We found an interaction between note-taking and prior knowledge on comprehension score, $F(1, 45) = 8.40$, $p = .006$, $\eta^2p = .15$ (Figure 2). The decomposition of the interaction showed that the comprehension score was higher in the “note-taking allowed” condition, particularly for participants with higher prior knowledge, $F(1, 45) = 7.26$, $p = .010$, $\eta^2p = .13$. No effect was observed in the “note-taking not allowed” condition, $p = .143$.

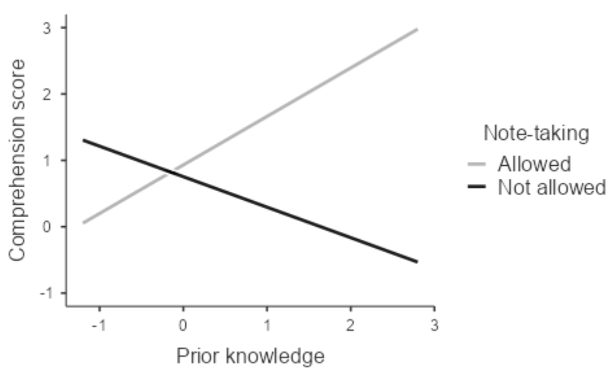

Figure 2: Comprehension score according to prior knowledge (Z-score) and note-taking (allowed vs. not allowed).

Finally, we observed a significant interaction between pauses, note-taking and age, $F(1, 45) = 6.05$, $p = .018$, $\eta^2p = .11$ (Figure 3). The decomposition of the interaction showed that the younger the participants (-1SD from the mean), the higher the comprehension score in the “note-taking not allowed” condition when they took pauses but this effect was not significant, $F(1, 45) = 2.18$, $p = .147$. We also observed no effect for the “note-taking allowed” condition, $p = .716$. On the other hand, the older the participants (+1SD from the mean), the lower the comprehension score in the “note-taking not allowed” condition, particularly when they took pauses, $F(1, 45) = 4.81$, $p = .033$, $\eta^2p = .09$. No effect was observed for the “note-taking allowed” condition, $p = .097$. In a nutshell, for older participants, comprehension score decreased when they took pauses and when note-taking was not allowed.

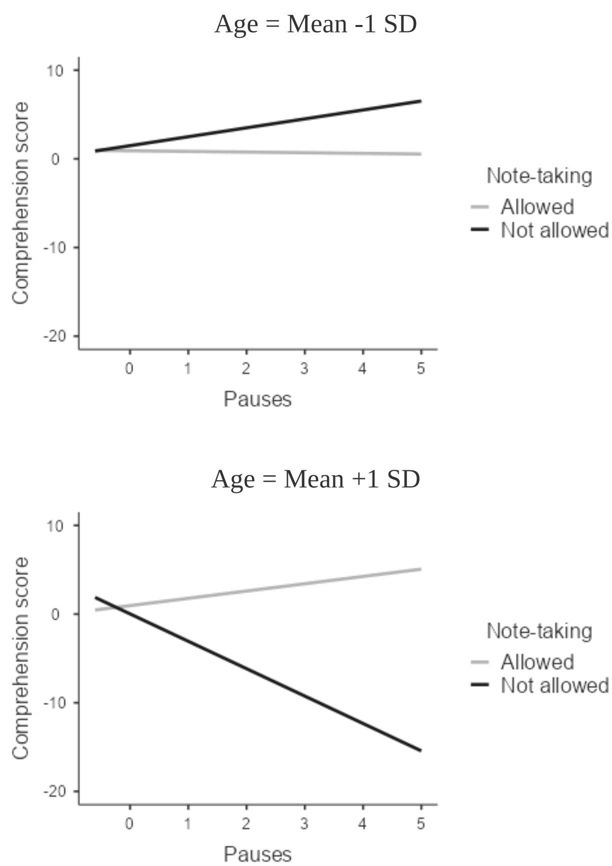

Figure 3: Comprehension score according pauses (Z-score) and note-taking (allowed vs. not allowed) for younger participants (-1 SD) and older participants (+1 SD).

Discussion

Previous studies showed that pauses are useful when learning in videos, but also that learners barely use pause option. A major critic to these studies is that video learning occurs in non-ecological situations, where note-taking is not allowed. This study aimed to test the effect of note-taking on pause behavior and on learning outcomes in an instructional video. We expected that learners who could take notes would do more pauses and have better recall and comprehension scores than learners who couldn’t take notes.

Results showed that learners, either they took notes or not, make few pauses overall. About 68% of learners did not make any pause, and for those who did, they made 2.14 pauses in average (in a 10-minute video). These results are coherent with previous studies showing that learners take few pauses, suggesting they don't know when or how to use them (Cojean & Jamet, 2022; Biard et al., 2018). In the current study however, contrary to our first hypothesis, results showed no effect of condition (i.e., note-taking allowed or not) on pause behavior. It means that offering the possibility of note-taking is not a sufficient condition to encourage learners to make pauses. Learners who could take notes were supposed to make pauses in order to facilitate their activity of note-taking (i.e., switch between understanding and production), but it appears that they mostly took notes without pauses. This study supports previous explanations on the difficulties for learners to identify the benefits of pauses, whether they take notes or not. Moreover, previous works indicated that explicit guidance in when and how to use pausing and scrollbacks on the timeline increased number of pauses, scrollbacks and performance in the comprehension test (Lin et al., 2022). These results underline the importance of instructions and guidance to help making pauses, even when note-taking is allowed.

Results also failed to show a significant effect of the condition on learning, thus invalidating hypothesis 2. However, note-taking availability seems to interact with various factors such as the number of pauses made, prior knowledge, or age. We found that prior knowledge was beneficial for comprehension in the “note-taking allowed” condition. We can suppose that learners with prior knowledge are better in focusing and retaining important information than learners with less prior knowledge, thus impacting the quality of notes taken. We also found that comprehension was reduced when older learners made pauses but could not take notes. Previous studies mainly involved young adults learners (e.g., Biard et al., 2018, Cojean & Jamet, 2022; Merkt et al., 2018), while it has be showed that cognitive performance decreased in normal aging (Klencklen et al., 2017). This study shows that comprehension relies on various factors that must be considered in ecological settings (e.g., MOOC), in which learners are not always young adults students and come from various backgrounds.

Some limits can be noted in this study. A first limit can be related to the fact that the study was online, and we did not control what the participants did during the procedure. For example, some studies showed that learners who take notes with computer are more likely to be distracted and to multitask (e.g., Jamet et al., 2020). However, even if online studies have some biases, they have implications for applied educational sciences. For example, the online procedure can be used to simulate multimedia learning in an ecological context, in the same way as learners in an online context (e.g., MOOC). In previous works, instructional videos were presented with a computer-controlled by an experimenter, and learners used separate computers for note-taking (e.g., Colliot et al., 2022; Bui et al., 2013; Luo et al., 2018; Mueller & Oppenheimer, 2014). Such non-ecological procedure can affect performance because learners must alternate between note-taking and the video's control (see Colliot et al., 2022). Moreover, the potential presence of an experimenter can induce experimental demand bias (e.g., Nichols & Maner, 2008), affecting pauses and note-taking results. Although online studies do not provide the same level of control over the study as in the laboratory, online studies viability is currently demonstrated (Sauter et al., 2020; Reips, 2021; Krantz & Reips, 2017) and they constitute an ecological setting to study learning in the context of instructional videos.

Another limit can be related to information presented during pauses. Indeed, while the last slide before pauses was still displayed when participants pushed the pause button, we did not control what information was displayed on the screen, which can differ among participants. In this perspective, Merkt et al. (2018) presented a black screen during pausing, rather than the last picture before pauses, to control this possible bias. However, we argue that the slide displayed during pauses is useful because this can facilitate the switching between production and understanding when note-taking is allowed. Indeed, this procedure allows participants to get down additional information from the slide that they might not have been able to collect without the slide during the pauses. Moreover, we did not analyze note-taking and pause strategies. It could have been interesting to see what patterns could emerge, depending, for example, on the perceived difficulty related to the content of each slide or on the video duration. It would be pertinent in future studies to use qualitative questionnaires to deepen understanding of cognitive activities during pause and note-taking strategies (e.g., Lee et al., 2020).

Finally, we did not observe a main effect of note-taking on learning scores, but rather interactions with prior knowledge and age. Previous works showed inconsistent results about note-taking or pauses with either no effect or effects observed in specific application domains depending on the topic (e.g., Biard et al., 2018; Lee et al., 2020; Luo et al., 2018; Merkt et al., 2018; Morehead et al., 2019), and suggested highlight moderators to explain inconsistent results (Fyfield et al., 2022). While the effect of prior knowledge on learning is highlighted in previous works, to our knowledge, we are the first study to show the effect of age on learning in online educational videos. Interestingly, previous studies showed that age is an important factor in WM performance, attentional processes, and cognitive load (e.g., Matysiak et al., 2019). For example, Klencklen et al. (2017) showed that 65–75-year-old adults performed worse than 20–30-year-olds on memory tasks, especially on WM tasks. In this perspective, older learners should have a smaller WM capacity and are less efficient in sharing attentional resources and alternating between storage and processing of information (Barrouillet et al., 2004). Given our results showing that age influenced the relationship between pauses and note-taking on learning performance, as well as works on age and WM (Klencklen et al., 2017) it would be relevant in future studies to measure cognitive abilities, including WM capacities to assess whether they affect pausing and note-taking strategies. Measuring individual differences will allow to highlight differences in cognitive abilities in order to improve learning in an educational video context (e.g., Lawson & Mayer, 2024).

To conclude, our results did not show a positive effect of note-taking on pauses or on learning outcomes. We found that allowing note-taking had a positive effect on comprehension for learners with prior knowledge. Moreover, the new contribution of this study is that age affected the relationship between pauses and note-taking on comprehension score. Future studies should consider age and other individual differences as moderating factors**,** replicate results and enhance learning with instructional videos. Finally, this finding allows to enhance learning in an applied context and increase the predictive power of multimedia learning theories.

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