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Are instructions in video format always better than photographs when learning manual techniques? The case of learning how to do sutures

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ABSTRACT

In faculties of medicine today, a growing number of medical procedures are taught in manual techniques workshops. These workshops leave the students only very little time to train. One solution to this problem would be to provide medical students with an opportunity to practice these skills by themselves thanks to online learning materials. In order to determine the instruction presentation medium best suited to complete this training, different formats were compared (video + audio, video + text, and photographs + text). Forty-eight students were required to do five sutures using one of these formats. Their performance was assessed by time measurements and measurements of the quality of the knots. For all of the time indicators, the results show that the videos were more effective than the photographs for the first trial. This trend was reversed for the following trials, where the performance levels recorded using the photographs were better than those using the videos. The quality of the knots, however, was systematically better with the photographs than with the videos for all of the trials.

1. Introduction

By the end of their studies, medical students must have mastered a number of theoretical concepts and must be able to demonstrate a certain level of skill in carrying out manual techniques or complex procedures. However, during the first few years of their studies, the students have very little hands-on instruction in these skills. It is only when they become interns, for example, that they learn how to carry out sutures or to intubate patients. Faculties of medicine are today gradually introducing training workshops to help students learn procedures such as putting on plaster casts, inserting a urinary catheter, or suturing wounds. However, the acquisition of these manual techniques requires repeated performance and practice, and therefore takes time. These intermittent workshops are consequently insufficient for the students to acquire the necessary level of manual dexterity and skill. Indeed, the acquisition of procedural knowledge – which includes manual techniques – requires a relatively high number of repetitions of the procedure, which is not possible over a short training period (Ganier, Hoareau, & Devillers, 2013). In order to optimize procedural learning by medical students, we conducted a reflection aimed at providing a complementary online training process which could be used up- or downstream of the training workshops. To this end, we carried out a study designed to determine which instruction presentation medium would be the most effective for medical students to learn how to do sutures by themselves. We thus compared three instruction formats: video with audio instructions, video with written instructions, and photographs with written instructions.

Prior to describing this study, we will present the theories that guided our thinking.

1.1. Learning procedures

The implementation of procedural knowledge, or “know-how”, usually results in the execution of a series of actions in order to achieve a goal (Bovair & Kieras, 1991). It may take different forms, from applying abstract knowledge when using a technical apparatus (e.g., a defibrillator) to carrying out manual techniques (when suturing wounds, for example). In both cases, the learning of this type of knowledge, notably studied by Anderson (1982, 1983, 1995) under the concept of skill acquisition, follows the same sequence of

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steps from a cognitive point of view. Thus, when learning a procedure, individuals seem to gradually move from a conscious to an automated processing of information. The passage from one to the other requires a certain amount of practice. At the end of the learning process, i.e., after a certain number of repetitions, the procedural knowledge is considered acquired when the learner is so familiar with the task, the equipment and the procedure, that he/she is then able to recall the procedure from long-term memory. At this point, knowledge is considered to be stored in long-term memory in the form of productions (Anderson, 1982, 1983, 1995) or schemas (Ayres & Paas, 2007a; Sweller, 1994, 1999). The actions are performed in a fast and accurate way. In terms of cognitive processing, only a few resources are required to carry out the task because it has been automated.

Work done in the field of understanding instructions, linked in some ways to procedural learning, has shown that in the early stages of learning (i.e., when the procedure is still unknown), individuals tend to develop different levels of mental representations from consulting instructions (Dixon, Harrison, & Taylor, 1993). The processing of information from instructions thus requires a certain level of cognitive "effort" on the part of the learner and therefore proves to be very costly from a cognitive point of view (Ganier, 2004; Heurley & Ganier, 2006). For example, Ganier et al. (2013) showed that the first instance of carrying out a procedure is characterized by systematic reference to the instructions. At this stage, each instruction is likely to be consulted at least once. These researchers showed that the cognitive cost of this phase results in a longer time necessary to carry out the procedure than in the following trials. With each new trial, the instructions are referred to less and less often, and the consulting of a single instruction results in the carrying out of several consecutive actions. This "proceduralization" process tends to both reduce the cognitive load on working memory, which is constrained in processing capacity (Baddeley, 1986), and increase the speed at which the procedure is performed, ultimately leading to the automation thereof (Anderson, 1982, 1983, 1995).

It is clear then that the interaction between long-term memory and working memory plays a significant role in procedural learning. According to Marcus, Cooper, and Sweller (1996), learning consists of schema acquisition and automation, with the dual function of storing information in long-term memory and reducing demands on working memory. However, an excessive load can be placed on working memory if the information given in the instructional material is not related to schemas already held in long-term memory. According to these researchers, difficulty in understanding is dependent not on the amount of information that must be assimilated but on the amount of information that must be held in working memory. In other words, the level of understanding of new material depends on the cognitive load imposed by the material. For example, poorly designed instructional materials impose a heavy load on working memory. Consequently, since the early stages of procedural learning strongly rely on working memory, it is important to reduce the cognitive load in order to facilitate learning (Sweller, 1994, 1999). To this end, procedural information needs to be presented in such a way that it minimizes extraneous cognitive load in order to be as effective as possible in facilitating learning (Brunyé, Taylor, & Rapp, 2008; Marcus et al., 1996). A number of principles for designing instructional materials effectively have been identified over the past two decades (Ayres & Paas, 2007; Mayer, 2014; Sweller, 2004). These principles are drawn from studies that have shown that the way in which instructions are presented has a direct impact on the processing of information in working memory and on learning (see for example the meta-analysis by Höffler & Leutner, 2007). We will focus specifically on the impact of presentation formats using still images (such as photographs or drawings) and moving images (such as video or graphic animations) on the carrying out of procedures.

1.2. The effects of still and moving images on the carrying out of procedures

For the past forty years, cognitive psychology and ergonomics have been examining the impact of the presentation of instructions, notably multimedia, on the performance and/or learning of procedures (e.g., Spangenberg, 1973). The numerous works in this field generally study the impact of different presentation media, ranging from text only to video, used alone or in combination (Groβe, Jungmann, & Drechsler, 2015; Van Genuchten, Van Hooijdonk, Schüler, & Scheiter, 2013). However, the advantages associated with the use of animated over still visual presentations in learning a procedural task have received little research attention. Amongst the published studies, relatively few have directly compared the impact of video with that of photographs. Comparisons generally focus on the presentation of still vs. animated computer graphics (Arguel & Jamet, 2009; Ayres, Marcus, Chan, & Qian, 2009; Castro-Alonso, Ayres, & Paas, 2015; Marcus, Cleary, Wong, & Ayres, 2013; Michas & Berry, 2000; Van Hooijdonk & Krahmer, 2008).

In the domain of procedural learning, studies have been conducted in a small number of practical applications, such as the disassembly of a weapon (Spangenberg, 1973), giving first aid (Arguel & Jamet, 2009; Michas & Berry, 2000), the prevention of musculoskeletal disorders (Van Hooijdonk & Krahmer, 2008), and the tying of knots (Ayres et al., 2009). Most of these studies report the advantage of using animation (either computer graphics or video). For example, in a *princeps* study, Wong et al. (2009) compared the effects of still and moving images on children learning origami. They showed that instructions presented in the form of moving images resulted in better performance levels than those in the form of still images (in terms of the initial learning period, time spent during the revision period, and number of participants who successfully completed the task). These results were confirmed by the same authors in two other studies involving other types of folding, more detailed behavioural analyses and children of different ages. According to these researchers, the learning of motor skills would benefit more from moving images than the equivalent still images: it is by observing the ongoing process of the activity being carried out that the participants can more easily learn tasks based on movements. Ayres et al. (2009) obtained similar results with young adults by comparing the impact of videos with that of photographs on learning to tie knots with scoubidou threads and on solving puzzles. The results showed that the participants who watched the videos performed better (in terms of time and quality) than those who viewed the still images. In addition, a subjective measurement of cognitive load showed that the participants who had viewed the videos considered the instructions to be easier to understand and follow than those who had used the still images. Arguel and Jamet (2009) also compared the impact of still and moving images on learning first aid. This time, three instruction presentation formats were compared: moving images (videos), still images (photographs), and a hybrid format combining both of the above. The answers to a questionnaire comprising ten open questions showed the best performance levels for the format combining both moving and still images. The moving images format (video) resulted in intermediate performance levels, while the levels were lowest with the still images format (photographs). These results are consistent with the meta-analysis by Höffler and Leutner (2007), which showed a fairly significant advantage of moving images over still images when the knowledge to be acquired was of a procedural nature (compared to problem solving or the acquisition of declarative knowledge). In line with these findings, Van Gog, Paas,