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Mental training in dentistry: A scoping review

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Abstract

Introduction: Clinical motor skills are essential to train dental students. There is evidence that imagery serves to acquire and improve motor skills, but there is scarce information on its application in dental education. In order to broadly map the available evidence and to detect knowledge gaps in the mental training used to develop motor skills in dentistry, a scoping review was conducted.

Materials and Methods: A structured search was conducted to identify relevant references from the Web of Science, Scopus and MEDLINE/PubMed databases for studies addressing mental training methods applied to develop motor skills in dentistry.

Results: A total of 758 articles were screened and four were selected, all of which were randomized clinical trials. Three studies investigated the effectiveness of visual imagery, and one investigated kinesthetic imagery. The research theme identified was motor skill acquisition.

Conclusion: The reviewed studies indicate the usefulness of mental training for skill acquisition in dentistry. To improve the generalizability of the results, further research with standardized mental training on motor skills in dentistry is needed.

KEYWORDS
dental education, mental imagery, mental practice, mental readiness, mental training, psychomotor skills

1 | INTRODUCTION

Dental training is facing great challenges, with shorter working hours, patient safety concerns and increased specialization reducing the training opportunities. New less-invasive procedures require the development of unique psychomotor skills. Simulators have emerged as a convenient option for skill development that allows repeated self-practice. However, existing simulation tools do not provide dental students with the same experience compared to performing on live patients.[1,2]

Furthermore, in order to improve the current methods used in dental training, tactile perception should be considered because improvements can hardly be achieved by repetition alone, similar to what happens when drawing a self-portrait: even if it is repeated countless times, the results will probably not improve. Neuroscience helps in this respect.[3] When people visualize themselves doing well at an activity, their chances of success at this activity improve. This is called mental rehearsal, and it is widely used by professional athletes and musicians to enhance their performance and reduce stress. Mental training is the process of mentally rehearsing the movements of a task, just like using the mind as a simulator. Imagery is useful to acquire and improve motor skills, because imagining an action activates the same neural areas as when this is physically performed.[4]

1.1 | Variants of mental training

Several terms have been used to describe the cognitive practice of a motor task, such as mental imagery, mental movements, mental

practice, mental rehearsal and motor imagery. Mental practice in motor skill learning refers to *motor imagery* (MI), which is the cognitive rehearsal of a physical skill in the absence of physical movement. Motor imagery leads to activation of the same brain areas as actual movement and has been shown to enhance motor performance. There are two main types of motor imagery: *visual* and *kinesthetic*.[5,6]

When mental practice involves visual imagery, it can take the form of either *internal imagery*, where the individual imagines him/herself experiencing sensations of the actual situation, or *external imagery*, where the person sees him/herself from the perspective of an observer, as when watching a movie. However, mental training involving kinesthetic imagery is the cognitive re-creation of the feeling of movements of a skill—the ability to imagine performing a movement by means of having an impression of the muscle contraction and sensation during an actual movement.[7] In summary, visual imagery involves self-visualization of action, whereas kinesthetic imagery implies somesthetic sensations elicited by action.

Variants of mental training have also been described in sport sciences.[8] *Subvocal training* consists of mentally repeating to oneself the practical sequence of the movement, all of which is verbalized in a conscious way by means of self-talk. In the training of *perception*, one should observe by means of memory or systematic evocation. The role of spectator is adopted, where one observes from an external perspective. *Ideomotor training* includes the inner perspective of an action sequence to be visualized. Learners imagine the movement from an inside perspective; they put themselves into the execution of the movement and try to feel it, perceiving forces, pressure, tension and relaxation. This concept would match the definition of *kinesthetic imagery*.

1.2 | Imagery ability

Another concept that may influence the effectiveness of mental imagery is an individual's ability to image. The ease or difficulty of using imagery as a form of mental practice is related to imagery ability. There is evidence indicating that imagery ability influences the effectiveness of mental practice, but also that mental practice provides benefits regardless of the level of imagery capacity.[9]

1.3 | Mental practice and technical skills in medicine

Experienced surgeons mentally rehearsed operations to prepare themselves for complex situations. Several studies have showed that mental practice can enhance the learning of medical procedures.[10–12] These results show that mental practice can be a cost-effective way to augment traditional surgical skills training.[10,13] In systematic reviews, mental training showed a positive effect in the acquisition of surgical technical skills.[6,14] Moreover, mental practice improves the accuracy and precision of surgical movements.[15]

The concept of mental practice is a method of fresh interest with an increasing number of publications in surgery.[16] In dentistry, however, mental practice has not been investigated in depth compared to the disciplines of psychology and medicine. Thus, the aim of this scoping review is to provide a comprehensive view of the mental training methods applied to develop motor skills in dentistry, identifying the approaches carried out in this field and the results and knowledge gaps for future research.

2 | METHODS

2.1 | Search strategy

A scoping review was conducted following the recommendations of the preferred reporting items for systematic reviews and meta-analyses (PRISMA-ScR). The aim of this scoping review is to provide a comprehensive view of the current evidence on mental training methods applied in dental education to develop motor skills, identifying the research conducted in this field, and the results and knowledge gaps for future research.

The PCC approach (population: dental students/dentist; concept: mental training and motor skills; context: dental education) was used to identify the keywords in the main review question: Which mental training methods have been used to develop motor skills in dental education? A literature search was carried out from inception up to November 2022 using three electronic databases: MEDLINE/PubMed, Scopus and Web of Science (WOS). The key search terms employed, in combination with Boolean operators, were as follows: “Mental Processes”[Mesh], mental imagery, mental training, mental practice, “Dentistry”[Mesh], education, “Dental”[Mesh], psychomotor skills, manual dexterity, fine motor skills, “Psychomotor Performance”[Mesh] and “Motor Skills”[Mesh].

2.2 | Eligibility criteria

Inclusion criteria were as follows: articles that review or assess mental practice/training in dentistry regarding its application for developing or increasing motor skills; articles from all countries; and articles published in English or Spanish. Articles not focused on mental training in dentistry were excluded.

Titles and abstracts were inspected independently for eligibility by two authors after eliminating duplications. Full texts were reviewed and preselected by two independent reviewers for potential inclusion.

Additionally, a manual search for relevant titles was carried out in each selected article's bibliography section. Any disagreement was resolved by discussion until consensus was reached.

2.3 | Data extraction and collection

Two reviewers extracted data independently using a data-charting form, piloted with the first two included studies to test their feasibility for the review.

The following data were extracted: author and year of publication, type of study, sample size, mental training method, assessment criteria, outcomes and conclusion.

3 | RESULTS

A flowchart summarizing the process for selecting those studies that answer the formulated question is shown in Figure 1.

Four studies were selected that reported the use of mental practice for developing motor skills in dentistry. The characteristics of the studies included in this scoping review, reported according to the type of mental practice, assessment criteria, outcomes and conclusion, are summarized in Table 1.

3.1 | Which mental training methods have been used to develop motor skills in dental education?

Four publications were found that applied different methods for the development of motor skills in dentistry. Three of these studies used visual imagery. Salvendy et al.[17] studied the effectiveness of perceptual training for the acquisition and retention of psychomotor skills in dental amalgam restorations. Prior to the actual amalgam restoration, students were trained in perceptual discrimination by using a movie with a detailed sequence and written messages; a photo library accompanied by a written message; and a fault library of common errors utilizing three-dimensional models.

Walsh et al.[18] investigated whether mental imagery ability could improve through mental practice and whether mental imagery practice could help students learn to administer an intraoral local anaesthetic. Practice lasting 15–20 min consisted of asking the students to close their eyes and mentally picture themselves preparing for and performing the injection. An instructor assisted the visualization process by verbally describing the steps involved. The instructor

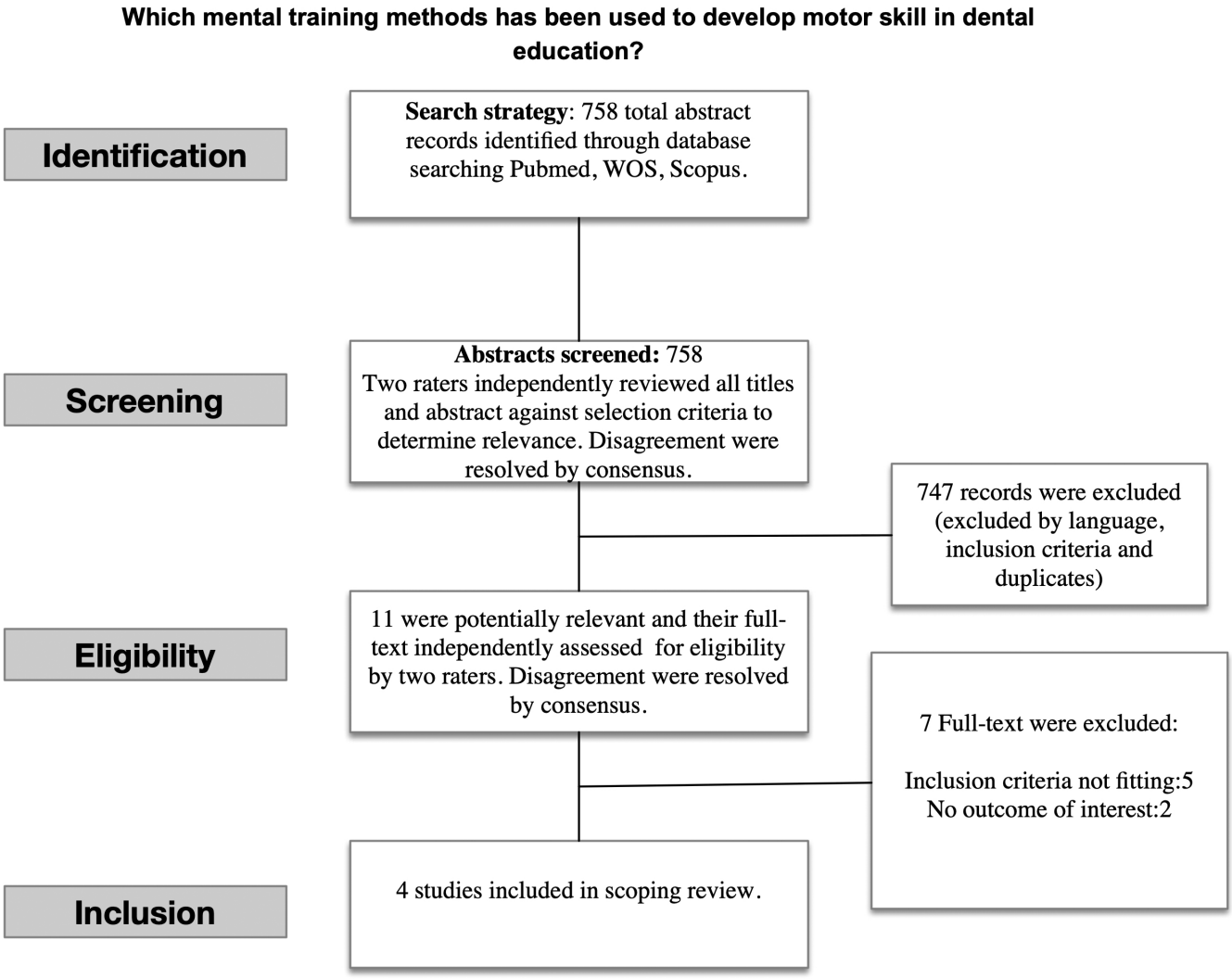

FIGURE 1 The PRISMA flow diagram of studies selection process.

TABLE 1 Characteristics of the included studies.

Author/ Publication year	Study	Sample size/ Participant	Mental practice method/ Intervention	Evaluation criteria	Outcomes	Author's conclusion
Salvendy G et al. 1976[17]	Randomized Controlled Trial (RCT)	72 Dental students	Perceptual training, self-paced/ after theoretical information: 18 IPT as control; 18 PMT, 18 PT and 18 PT + PMT as experimental.	Quality, performance time, retention of the acquired skills and financial comparations	Quality of performance was higher but not statistically significative for IPT; the training time of the experimental group was less than IPT and they placed the restoration faster; self-paced programs result in higher retention; Cost of IPT is higher	Self-paced instruction results in higher retention of the acquired skills than conventional training methods and is economically feasible to develop.
Walsh, M. et al. 1984[18]	RCT	18 Dental and hygiene students	I + VD as control; I+ VD + mental imagery (Close eyes and see themselves performing) before clinically administering intraoral anaesthetic as experimental.	Unacceptable: student is unable to proceed; satisfactory: verbal correction to administer correctly; ideal: student proceeds correctly with no verbal feedback	Mental Imagery group almost doubled the degree of improvement of the control group for clinical performance of intraoral anaesthetic administration.	Mental practice can help with skill learning.
Welk A. et al. 2007 (2)[19]	RCT	41 First-year dental students	Short concentration exercise, subvocal and ideomotoric training / practical training on the computer-assisted dental simulator for both pre- and post-test (2 days after the last mental training) before instructor demonstration	Based on the DentSim records, the process of the entire preparation was analysed by means of 7 operational parameters, which were adapted for tooth preparation from the Objective Structured Assessment of Technical Skills (OSATS)	After the instructional intervention, the quality of the preparation improved in both groups; improvements in the knowledge, process and quality parameters were significantly better in the mental training group.	Significantly greater improvement of the mental training group in learning and performance.
Jofré J. et al. 2019 (1)[20]	RCT	17 First-year dental students	For 5 days, participants performed 30 min of "mental practice" after visualizing a video showing the execution of an ideal inlay preparation, alternating it with black screen periods and keeping the audio guide to facilitate the visual imagery	Accuracy percentage of the preparation performed physically regarding the ideal	Accuracy in execution showed no significant differences between the groups; the time required by the mental training group was half the time required by the conventional group	Mental imagery training in preclinical dental students could be as effective as conventional physical practice to perform teeth preparations.

Abbreviation: IPT, Instructor + physical training; PMT, psychomotor training, I, Instructor; VD, Video Demo.

used a slow, cautious tone in describing the process of advancing to the terminal deposition site. Students were told to imagine how far the needle would be inserted when it reached the deposition site.

The report of Welk et al.[19] studied the impact of kinesthetic imagery on dental crown preparation. In this study, learners alternate between mental training and actual practical exercises. The participants in the mental training group were trained by a sport psychologist using a detailed instructional handbook. The instructions in the handbook were based on detailed analyses of current descriptions of crown preparation, which were reduced to the nodal points. The necessary instruments and their correct usage, the related motor instructions with concrete short comments about potentially dangerous junctures and clinically helpful advice were given for each nodal point. After a short concentration exercise, participants in the experimental group performed subvocal and ideomotoric training, as used in professional sports.

Jofré et al.[20] examined the feasibility of three-dimensional visualization associated with mental imagery on the development of fine motor skills in dental students. For 5 days, participants performed 30 min of "mental practice" per day after visualizing and listening to a three-dimensional video showing the execution of an ideal inlay preparation, alternating it with black screen periods and keeping the audio (dental drill sound during tooth preparation) to facilitate the imagery of this procedure. The control group performed 5 days of conventional training: 30 min of "hands-on practice" of the same inlay preparation per day. After 5 days, both groups physically carried out an inlay preparation on a manikin.

3.2 | What have been the study results addressing mental training for developing motor skills in dentistry?

In all of the selected experimental research studies, an improvement in motor skill performance of dental procedures was observed after different types of mental training compared to a control or an alternative form of practice.

Salvendy et al.[17] found no statistically significant difference using perceptual training for the acquisition of psychomotor skills in dental amalgam restorations, compared to conventional training with regard to the quality of performance. However, training through self-paced analytical programmes results in higher retention of the acquired skills than training through conventional methods, and the total training time for the perceptual group was 16% less than that for the conventional group.

Walsh et al.[18] found a trend toward higher improvement in the mental imagery group (almost double that in the control group) for the clinical performance of intraoral administration of local anaesthetics. However, because of the small sample size, only one of the studied injection techniques showed a statistically significant effect in favour of mental practice.

In Welk et al.[19] students showed an improvement in learning and performance of a crown preparation after mental training. They felt much better prepared for the procedure and most of them wanted to use and could imagine themselves using mental training for future tooth preparations.

Jofré et al.[20] found that visualization associated with mental imagery training in preclinical dental students could be as effective as conventional physical practice to perform teeth preparations. The time required to prepare a tooth by the mental training group was half the time required by the conventional group.

Despite the small number of publications in dentistry, the findings suggest that mental imagery practice can help in the learning of psychomotor skills.

4 | DISCUSSION

In the studies reviewed, mental training achieved the same results as physical practice or an alternative form of practice. This is consistent with the use of mental imagery to improve the motor skill performance of other disciplines.[6,12,14,16,21,22]

Due to the few studies available, it is difficult to provide a standard framework or model of the most effective mental imagery elements for motor skill acquisition in dentistry. However, it is possible to extrapolate information from the extensive published data in a comparable medical area, such as surgery, where evidence has suggested that mental imagery leads to improved clinical performance. Randomized controlled trials demonstrated that trainees exhibit superior technical skills after a brief period of mental practice, whether performing tasks such as simple sutures, cystoscopies or complex laparoscopic cholecystectomies.[23]

In essence, what has emerged from a number of studies that looked into the effect of mental training on the acquisition of surgical technical skills is that through mental practice (MP), less experienced surgeons can shorten their learning trajectories. Implicit in this view is that MP is a transferable competency.[22] Although the literature has proposed the use of MP in surgical education, based primarily on the beneficial role of mental training in surgical tutoring, there is a need for more thought about MP acquisition and assimilation among users, as well as the important implications of mental rehearsal and its contribution to safety.[16]

In a systematic review and meta-analysis of the role of mental training in technical skills acquisition in surgery, Rao et al.[14] reported that RCTs that demonstrated a positive impact of mental training involved a systematic and sequential mental training program lasting at least 30 min, using scripts that go beyond the simple procedural steps traditionally described in textbooks. Instead, these scripts contain detailed cues that help the learner to imagine the actual movements related to the task. Scripts with more than 35 cues were the most effective. Some studies included specialists for relaxation and guidance through mental imagery.[14]

A recent review of current evidence for mental practice in surgical training found that the majority of studies demonstrate benefits of MP for technical performance.[24]

MP will augment physical practice, and it remains a viable strategy to enhance and develop surgical training. MP is affordable and easily accessible for universal use but requires trainers who are proficient in the creation of mental scripts. The process of deconstructing complex surgical procedures must be standardized, and mental scripts must be validated by expert surgeons and will require sufficient detail and kinesthetic cues to facilitate meaningful mental imagery and MP.[24]

As seen in the literature, the method of application of mental imagery may determine the effectiveness of the training. The studies included in the present scoping review have shown the effectiveness of mental practice for the acquisition of motor skills in dentistry. In light of the identified variables that may moderate or mediate the relationships between mental practice and motor performance in dentistry, we have suggested future research that may eventually help to verify whether these determinants actually produce the suggested relationship and thus move us toward a better understanding of mental practice and its potential application in dental education.

4.1 | What are the knowledge gaps for future research?

To use mental training as an effective tool, technical skills must be assessed in a standardized and reproducible environment, establishing a mental training protocol using an instructional programme with detailed mental scripts developed by specialized personnel to guide the mental imagery and using visual and auditory sensory modalities that facilitate effective mental practice.

Mental training interventions with positive results based their methodology on a detailed mental script, where participants received acoustic and detailed instructions that divided the task into individual steps with key nodal points related to sensory cues.[8,14] Participants kept their eyes closed, with internal imagery and kinesthetic MI modes and sufficient time to rehearse the script carefully.[14]

Besides the detailed description of a procedure to be carried out, mental training requires phrasing of the instructions. The description of a procedure must first be reduced to nodal points. These nodal points are necessary structural motoric components that must be performed in sequence and are marked by a reduction of the degrees of freedom of action.[8]

In psychology, Driskell et al. determined under which conditions MI was most effective. They defined the following criteria: examination mainly of the cognitive aspects of the task performance, short retention interval, participants being novices to the task and the MI session being about 20 min or shorter.[6,25] Even when the delay between mental practice and performance has not been systematically investigated, studies indicate that mental practice may be most effective when done immediately (within 10 min) prior to performance.[26]

Procedures (e.g. a complex, invasive treatment) should be clearly and precisely ordered and described to make it easy for novices to make correct decisions that require an initially high level of knowledge.[27] Mental training could make treatment not only more economical but also safer by allowing students/practitioners to avoid errors by focusing on safety-relevant issues depicted in a structured instructional handbook.[19]

Studies have shown that physical practice is slightly more effective than mental practice and that mental practice is better than no practice. However, using a combination of physical and mental practice often involves only half as many physical practice trials as physical practice alone.[28,29] Several studies indicate that mental training should run in parallel with physical training to be more effective, as the sense of touch transmits much more information to the brain, allowing better connection and experience of virtual reality.[6,14] Future research should also consider the use of dynamic kinesthetic imagery, which is the cognitive creation of the sensation of movements while physically moving. For example, one can imagine the sensation of playing piano while moving the fingers of the hand.[30]

Simulation allows for risk-free training in technical skills and mental training has the potential to be associated with a number of different technologies that could provide a multisensory environment to help users become completely immersed in an artificial environment that emulates real-life procedures.

The application of advanced technologies to mental training strategies for assessing surgical skills is not far behind. In essence, the clinician could rehearse the actual procedure before performing it live, in which case the learning curve for difficult or unusual cases would not involve risk for the patient and the real-world surgical outcome would be enhanced.[31]

4.2 | Limitations

Studies in languages other than English or Spanish were excluded, meaning that other potentially relevant studies were omitted. Additionally, the search strategy used bibliographic databases but did not include any non-peer-reviewed or non-indexed literature. Although this may have resulted in the exclusion of relevant articles, the breadth of the databases included in the final search should have reduced the impact of this limitation.

5 | CONCLUSION

Mental training based on visual or kinesthetic imagery with a detailed mental script, using visual and auditory sensory modalities, is an effective method that may be used as an alternative or adjunct to physical practice in order to develop motor skills in dentistry. To improve the generalizability of the results, further research with standardized mental training on motor skills in dentistry is needed.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to disclose.

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DATA AVAILABILITY STATEMENT

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

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