ORIGINAL REPORTS

Perfectionistic Concerns are Detrimental to Skill Learning for Minimally Invasive Surgery

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BACKGROUND: The pursuit of high standards and continuous self-improvement are important aspects of a professional attitude in medicine. However, when identity and self-esteem are dependent on flawless performance, healthy striving can become perfectionism. The present study examines the influence of perfectionism on the learning process of basic instrument handling for minimally invasive surgery (MIS).

METHODS: Thirty medical students volunteered to participate in the study (19 females, 11 males). The mean age was 19.8 years (SD = 1.8). The Perfectionism Inventory was used to determine the degree of perfectionist characteristics in two main factors: Self-evaluative perfectionism and Conscientious perfectionism. Participants practiced with the loops and wire task on a surgical simulator and were tested for skill retention within 48 hours. During practice instrument movement was captured in three-dimensional space using a Leap Motion controller. Performance was assessed by time and total path length travelled by the instruments.

RESULTS: Self-evaluative perfectionism was negatively related to skill retention with regard to movement efficiency, but did not predict change in average time on task. The Conscientious perfectionism factor was not a predictor of skill retention with regard to path length or completion time.

RESULTS: Self-evaluative perfectionism was a significant predictor of change in average pathlength between sessions but did not predict change in average time. The Conscientious perfectionism factor was not a predictor of changes in path length or completion time.

CONCLUSIONS: Overly negative self-evaluation during MIS skill practice undermined the learning process. Trainees with self-critical perfectionistic tendencies may not optimally benefit from their efforts during practice. (J Surg Ed 000:1−8. © 2020 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Perfectionism, Surgical skill learning, Surgical education

COMPETENCIES: Patient Care, Professionalism, Practice-Based Learning and Improvement

INTRODUCTION

The advent of minimally invasive surgery (MIS) has brought many benefits for the patient, such as smaller incisions, less postoperative pain and a shorter recovery time.[1] For the surgeon, however, the application of this approach requires a higher level of skill and increased concentration as one can rely less on tactile feedback during surgery, and in the case of conventional laparoscopy the visual image is presented in a distorted way.[2] Although mastery of the technique requires more investment from the surgeon, the time that is available for practice may not always be sufficient to meet the training needs of surgery residents.[3] Thus, in order to support trainees in making better use of the time available to them, it is necessary to investigate specific surgeon-related factors that can support the efficiency of the learning process.

In the interest of patient safety, it is important for doctors to realize that they have a certain degree of control over the prevention of adverse events.[4] That sense of control is developed by becoming aware of inadequate performance in a particular area and remedying it through additional training or consultation with other professionals. Accordingly, pursuing a high standard and continuous self-assessment are considered important components of a medical professional attitude.[5-7] However, when

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  1931-7204/$30.00 https://doi.org/10.1016/j.jsurg.2020.08.022

identity and self-worth are linked to flawless performance and excessively high standards are relentlessly pursued in the face of negative consequences, healthy striving can become perfectionism.[8] Not surprisingly, perfectionism is a common characteristic among surgeons,[9,10] surgery residents,[11] and medical students.[12-14]

In early research into perfectionism the construct was treated as one-dimensional and considered as a predominantly maladaptive trait.[15] However, at present, a considerable amount of research has indicated that a division can be made in the construct[16-18]: the first dimension has been defined as perfectionistic strivings, which describe the pursuit of high internal standards. The second dimension has been defined as perfectionistic concerns, which refers to the fear of being judged negatively by others if the result is not perfect. Although positive correlations are usually found between these dimensions, they show different relationships with affect, motivation and performance.[19,20]

When performance falls short of a certain standard, perfectionists who are concerned about preventing negative judgments from others tend to focus selectively on their shortcomings, which prevents a problem-oriented approach.[21] This can lead to task avoidance and reduces motivation over time,[22] which in turn generates more tension because the self-image is still dependent on performance according to set standards.[23] Furthermore, when standards are actually achieved, perfectionists of this type usually do not derive satisfaction from success, as they have only done what was expected of them.[24] Consequently, this dimension of perfectionism shows positive links with anxiety, depression, and burnout.[25-27]

Perfectionistic strivings on the other hand comprise a more ambiguous type of perfectionism. This dimension also shows relationships with negative outcomes such as anger and frustration when performance does not correspond to certain standards,[28] but also connections with adaptive outcomes such as increased self-efficacy, goal achievement, and autonomous motivation.[29-31] Possibly, these positive outcomes are achieved because this type of perfectionist tends to work actively and problem-oriented in response to stress,[32] which leads them to invest more time in the task at hand.[33,34] Furthermore, because the self-image is dependent on high-quality performance, standards are continuously raised when goals are reached.[35] In excess, however, this habit may become an all-encompassing preoccupation, which can result in mental and physical harm.[36]

To date, a multitude of studies have examined the influence of perfectionism on performance in various areas such as sport and academic performance. With regard to MIS skill learning however, to our best knowledge no such study has yet been conducted. The present study investigates the influence of the different dimensions of perfectionism on learning basic instrument handling for MIS. In earlier studies, perfectionistic strivings have shown positive relationships with performance, while perfectionistic concerns have been associated with lower achievement behavior. It is therefore expected that participants high in perfectionistic strivings will demonstrate higher learning gains, and participants with high perfectionistic concerns will benefit less from their practice efforts.

MATERIAL AND METHOD

Ethics

Ethical approval for the study was granted by the medical ethical committee of the Erasmus MC Rotterdam.

Apparatus and task

A laparoscopic training setup was used in this study (Fig. 1). Movement of the instruments was occluded from direct view. A video image of the task area was captured with a fixed camera and displayed on a 17-inch computer monitor that was positioned on eye level. Participants practiced on a shortened version of the loops and wire task, commonly used in surgical training to develop bimanual instrumentation. The exercise required participants to pass a wire through 2 loops on a 3D printed board (Fig. 2), using grasper forceps. The starting position of the wire was designated on the exercise board.

During practice, the movements of the tips of both instruments were captured in three-dimensional space using a Leap Motion controller. The Leap Motion controller is a device that can be used to track multiple pen shaped objects simultaneously using infrared sensors.[36] A custom software program (created by OCRAM technologies), implemented in Python 2.7, was used to extrapolate the motion data from the position of the white tube to the tip of the instrument and to record the duration of the trials. To assess performance, the following parameters were recorded: time to task completion,

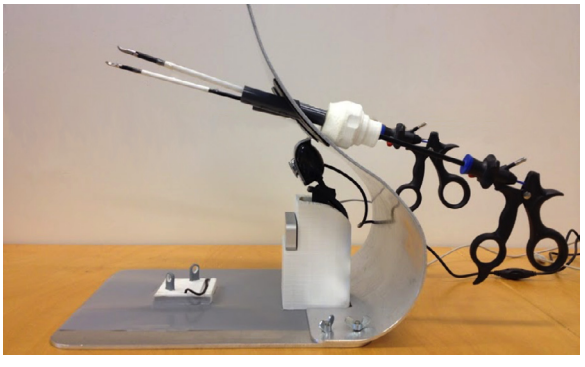

FIGURE 1. Experimental setup.

FIGURE 2. Loops and wire task.

defined as the total time used to pass the wire through both loops; and path length, defined as the total distance travelled by the tip of the instrument during the task.

Data registration was started and stopped per trial by the participant by pressing the space bar of a keyboard. After stopping the trial, participants placed the wire back in the starting position by hand. Because one hand was needed to press the space bar, the software considered the start time as the moment when the tips of both instruments were detected to be within the working area of the task, and the stop time when either instrument left this area. The working area of the task was defined as any location below 100 mm on the y-axis as registered by the motion sensor.

In order to determine the required amount of repetitions in the practice session, 5 participants that were not included in the study were asked to practice on the task for one hour. On average the learning curve of these participants started to flatten out around the 15th repetition. To make sure enough practice took place for skill consolidation, double the amount was chosen as the amount of trials to be done by participants.

Measures

Performance on the surgical task was assessed per trial by total time to completion and total path length of both instruments. To determine the degree of perfectionist characteristics, the Perfectionism Inventory was used.[38] This questionnaire consists of 59 items in 8 subscales: Striving for Excellence, Planfulness, High Standards for Others, Organization, Concern over Mistakes, Need for Approval, Parental Pressure, and Rumination. The total score on the first four subscales together form the higher order factor Conscientious perfectionism, and the combination of the other sub scales make up the factor Self-evaluative perfectionism. These higher factors relate respectively to the dimensions perfectionistic strivings and perfectionistic concerns described above. Items are rated on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The authors of the scale demonstrated validity and reliability for the PI.[37]

Participants

Thirty medical students volunteered to participate in the study (19 females, 11 males). The mean age was 19.8 years (standard deviation [SD] = 1.8). Twenty-six participants were right-handed, and four were left-handed. All participants had normal or corrected-to-normal vision with no other physical impairments.

Procedure

Prior to the experiment, all participants gave written informed consent. After completing the questionnaire, handling of the instruments was explained and a demonstration of the task was performed by the experimenter. Next, the participants completed 30 consecutive trials on the surgical simulator. Within 48 hours, participants returned and performed another 5 trials.

Statistical analysis

Skill retention was assessed by calculating the slope of the regression line between average performance on the last five trials of the practice session and the five trials of the retention session. As lower values on both outcome measures reflect higher efficiency in task execution, negative slopes would imply increased performance retention, whereas positive slopes (or relatively less-negative slopes) would represent decreased retention. Simple linear regression analyses were carried out to investigate if the dimensions of the Perfectionism Inventory independently predicted skill retention on the surgical task. We used an alpha level of 0.05 for all statistical tests. All analyses were performed in SPSS 21.

RESULTS

Questionnaires

On average, participants scored 93.63 (SD = 14.39) on the Conscientious perfectionism factor, and 86.30 (SD = 18.79) on the Self-evaluative perfectionism factor of the Perfectionism Inventory.

Surgical task

Practice session

Simple regression analysis revealed that path length and completion time at baseline were not significantly predicted by either Self-evaluative perfectionism or Conscientious perfectionism (ps $>$ 0.1). Mean duration of the total practice session was 37.50 minutes (SD = 9.79).

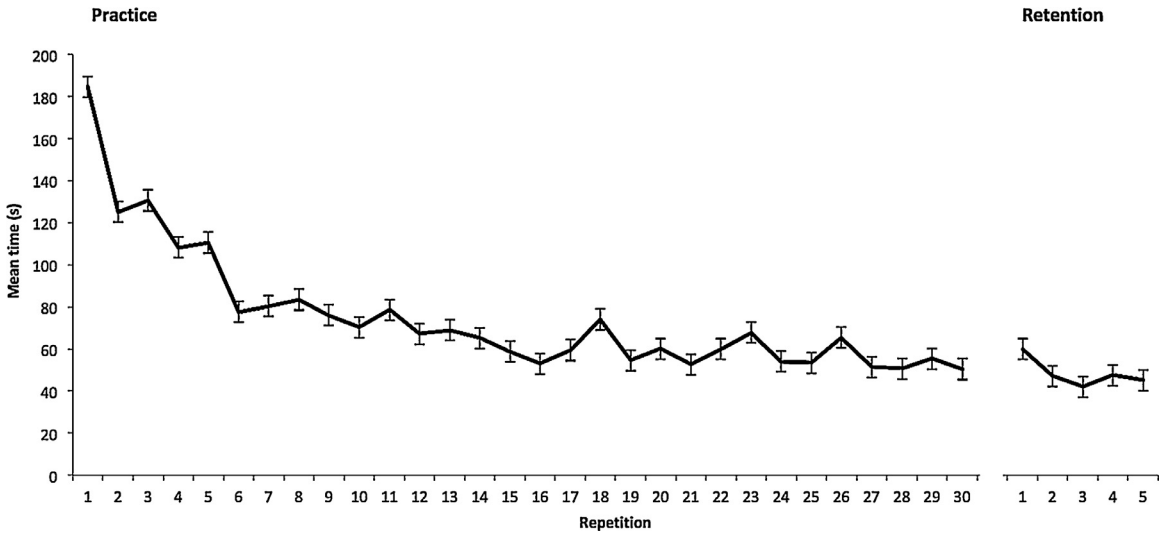

FIGURE 3. Average time to completion in seconds per repetition on the loops and wire task with standard error.

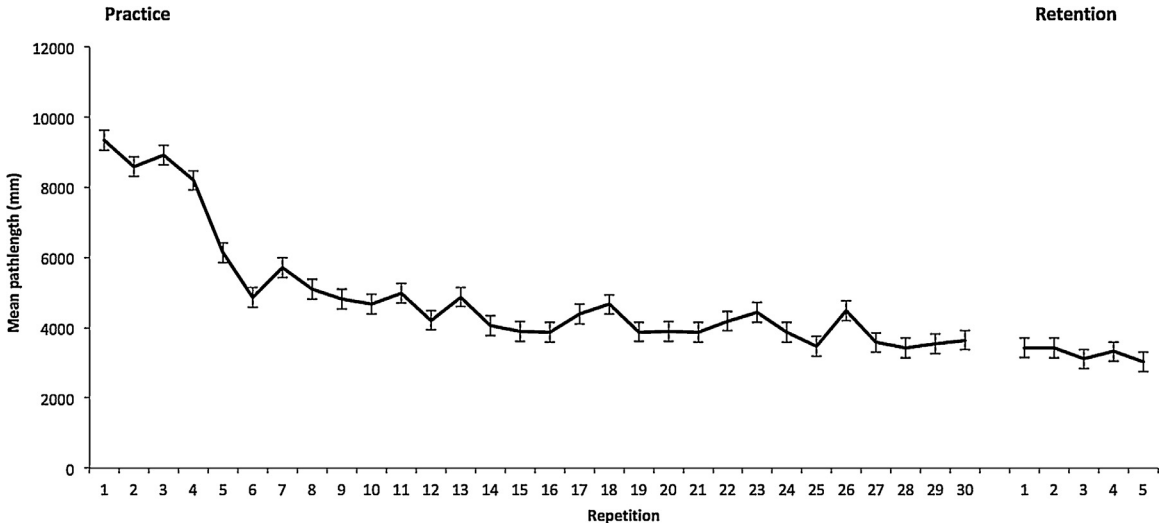

FIGURE 4. Average pathlength per repetition on the loops and wire task with standard error.

The changes in task completion time and total path length with increasing experience during the practice session and the retention session are shown in Figures 3 and 4, respectively.

Mean average path length on the last 5 trials was 3631.43 mm (SD = 1565.43). Mean completion time on the last 5 trials was 56.03 seconds (SD = 24.55). During the last five trials, the Self-evaluative perfectionism factor score did not significantly predict average pathlength (= −0.263, p = 0.16), or average time (= −0.13, p = 0.48). The Conscientious perfectionism factor also was not a predictor of path length (= −0.203, p = 0.841) or completion time (= −0.103, p = 0.59) during the last five trials.

Retention session

Mean average path length on the five task repetitions on the second day was 3504.71 (SD = 1575.80). Mean completion time was 51.62 seconds (SD = 13.52). Mean slope of the regression line between average performance on the last 5 trials of the practice session and the 5 trials of the retention session was −441.85 (SD = 1481.18) for pathlength, and −4.41 (SD = 23.52) for time. Simple regression analysis revealed that the Self-evaluative perfectionism factor score was a significant predictor of pathlength slope (= 0.459, p = 0.011), explaining 21.1% of the variance (Fig. 5), but did not predict time slope (= 0.22, p = 0.26). The Conscientious perfectionism factor was not a predictor of path length slope (= 0.16, p = 0.39) or time slope (= −0.79, p = 0.68).

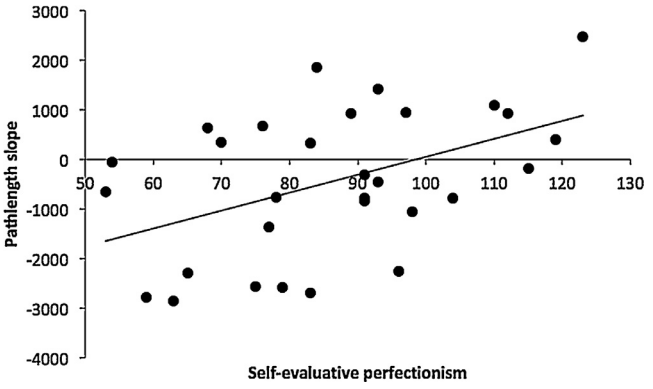

FIGURE 5. Scatterplot showing the association between Self-evaluative perfectionism and the slope of the regression line between average pathlength on the last five trials of the practice session and the five trials of the retention session.

DISCUSSION

The present study examined the relationship between perfectionism and motor skill learning for MIS. To this end, novice participants practiced with a basic task in a surgical simulator, after which skill retention was assessed on a separate day. Performance was measured on the basis of time to completion and total pathlength of the instruments. Trait perfectionism was captured using the Perfectionism Inventory.

The results partly supported the expected associations. The Self-evaluative perfectionism factor was related to reduced learning gain with regard to movement efficiency, but was not related to differences in completion time. No effects were found for the Conscientious perfectionism factor. The findings of the present study imply that during the learning process of manipulative skills for MIS, excessive negative self-evaluation may interfere with advancement in movement efficiency. More generally, the findings of this study support the view that perfectionistic strivings and perfectionistic concerns are associated with different behavioral outcomes, and that that perfectionistic concerns can undermine performance.[19,20]

When practicing a new motor skill, it is useful to try out different ways of moving, in order to arrive at a personal movement style that feels natural and composed. As perfectionists generally have a strong need for certainty and struggle in ambiguous or novel circumstances,[39] discomfort with their initial inadequacy may have caused them to micromanage their movements, thus restricting the intuitive exploration of new ways of moving. This rigid way of practice may have resulted in lower rates of skill retention, as research in the motor learning domain has suggested that excessive reliance on conscious processes during motor learning can interfere with the automaticity of movement.[40-42] Moreover, as self-critical perfectionists tend to focus on their shortcomings in the face of difficulties,[21] rumination on deficiency with instrument handling may have impeded active engagement with the task at hand. Furthermore, perfectionistic concerns are associated with a greater likelihood of experiencing anxiety in relation to discrepancies with estimated performance norms.[43] During the assessment of skill retention on the second day, uncertainty about being able to reach certain standards may have caused individuals with this disposition to experience a heightened level of stress. In previous studies it has been demonstrated that such psychological stressors can lead to increased muscular activation and co-contractions.[44,45] This muscular overuse could in turn have resulted in loss of motion fluency. Subsequent research could obtain additional outcome measures such as EMG, salivary cortisol, heart rate variability and skin conductance in order to investigate the possible moderating role of stress.

As for perfectionistic strivings, it is interesting to note that, although this characteristic is associated with higher task investment,[33,34] it was not associated with better performance outcomes in this study. A possible explanation for this is that the processes underlying perfectionistic strivings do not directly influence the process of skill progression, but rather indirectly through sustained efforts and continuous raising of performance standards over time. However, taking into account the efforts made to achieve a certain level of performance, a distinction can be made between absolute and relative performance.[46] When performance is compared to invested effort, internally oriented perfectionists may well reach a higher level of performance over time, but they may not be as efficient during the process as people who are less demanding of their own performance.[47]

This study has some limitations. First, to ensure the absence of any distracting factors, participants practiced in isolation during the experiment. In an educational context, normally training occurs in the presence of peers and supervisors. Since self-critical perfectionists are prone to experience shame when they perceive their performance to be sub-par in the eyes of others, in a more realistic context the presence of other people may magnify the effect of this characteristic on their learning process. With regard to ecological validity, subsequent research may look into the effect of perfectionistic tendencies in a group setting, such as during a surgical skills course. Second, to best compare performance between participants, all participants were asked to do perform the same amount of task repetitions. Previous studies have shown that perfectionists that are self-oriented tend to persist in practice for longer periods of time, whereas self-critical perfectionists are prone to give up as difficulties arise during practice. With regard to the

current experiment, possibly some participants would have quit earlier or persisted longer if they were not asked to complete a fixed number of trials. Thus it would be of added value to also investigate the effects of perfectionism when practice occurs in a more self-controlled way. Third, the study population consisted of first year medical students exclusively. The ages within the sample group therefore fell within a narrow range, and participants were relatively young. In terms of age, developmental research has provided evidence for a decline in perfectionism as people grow older.[48] Therefore, the effect of perfectionism may be less pronounced in later phases of peoples surgical careers, as perfectionistic tendencies might be somewhat lowered. Future research will have to demonstrate the generalizability of the current findings to later phases of the surgical career, such as during residency or among surgeons that have been in practice for some time.

Because perfectionism is a common disposition among surgical residents, it is likely that a significant proportion of trainees will not be able to take full advantage of their opportunities for practice. To increase the efficiency of MIS curricula, it may be beneficial for educators to be considerate of this characteristic among surgeons in training. Studies of psychological interventions that target perfectionism suggest that it is possible to reduce perfectionistic tendencies.[49,50] Possibly, surgical educators could introduce aspects of these interventions into their practice. This can be achieved primarily by creating an environment where it is safe to take risks and there is room to make mistakes. When trainees appear to be apprehensive during practice, it may be helpful to examine their expectations and help re-evaluate them. In this regard, shifting the aim from perfection to progress can help to maintain perspective of the broader context. In addition, the focus on shortcomings can be reduced by emphasizing points of success and framing errors in a positive way.

FUNDING

The authors report no external funding source for this study.

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