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The Influence of Peer Feedback on the Acquisition of Physical-Examination Skills

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Abstract

Studies have suggested that having students observe peers while acquiring physical-examination (PE) skills fosters the acquisition of the psychomotor skills required to conduct a PE. One difficulty, however, has been to disentangle the effect of peer observation from peer feedback, both of which occur when students learn in groups. This study investigated the influence of peer feedback on learning the neurolocomotor physical exam for low-back pain. 120 second-year medical students were randomly assigned to a peer-feedback group ($n=61$) or a no-peer-feedback group ($n=53$), during a regular learning activity with a standardized-patient instructor. Students first practised the NLE in groups of three, with or without peer feedback, depending on the group to which they were assigned. Subsequently, the members of both groups performed the NLE individually. The final NLE was videotaped and assessed later. Peer feedback had a positive effect on the acquisition of PE skills (87.9% vs. 90.8%, $p=0.023$), despite the fact that students had an initial preference for instructor feedback compared with peer feedback. These results support the use of group activities that give students the opportunity to provide feedback to their peers while learning PE skills.

Keywords: Psychomotor skills; Peer feedback; Learning; Peers; Physical examination skills

1. Introduction

Physical-examination (PE) skills essential for good clinical performance are usually taught in small groups[1,2] by demonstrating the skills and then providing feedback as students practise them. While this approach is widespread, medical students in a small-group setting know little about the factors that facilitate the acquisition of PE skills. Of the factors that have been studied, observation of peers seems to contribute significantly to psychomotor-skill acquisition.[3,4] With respect to peer influence on PE learning, however, it has been difficult to disentangle the effect of peer observation from that of peer feedback, because both observation and feedback occur simultaneously when students learn together in a naturalistic setting. This article reports on a study aimed at clarifying the specific influence of peer feedback on the acquisition of PE skills in a natural small group learning setting.

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Mastering the PE requires medical students to learn and integrate several psychomotor skills. There is some evidence that observing peers may facilitate acquisition of these skills. Ste-Marie et al.[5] reviewed the literature on model observation using the lens of social-learning theory[6] to explore how observation improves the acquisition of motor skills and subsequent sport performance. Peer observation helps because it allows the learner to build up a model that acts as an intermediary blueprint against which the learner can compare his or her own performance, making it easier to detect and correct mistakes.[7,8] For PE skill acquisition, in a natural-learning environment, Martineau et al.[3] showed that second-year medical students who had the opportunity to observe peers while learning an integrated PE performed better than students who did not have this opportunity. A second study by the same team showed that the effect of observation was enhanced when students observed a peer who performed well compared to observing a weaker performance while learning the NLE for low-back pain.[4] Nevertheless, it was difficult to isolate the effect of peer observation in the aforementioned studies from other potentially confounding factors, one of which is feedback.

Van de Ridder et al.[9] defined feedback in clinical education as "specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance." This implies that learners receive information from a teacher or from another learner on achieving task goals. Key feedback elements are comments on their actual task performance as well as suggestions on the next steps to be taken in order to raise their level of performance. When learning PE skills in groups, both feedback (from teachers and peers) and the observation of others are part of the learning process. It may be difficult in these contexts to isolate the specific effects of feedback on learning from those of observation.

Hattie and Timperley[10] found that feedback had an effect size on achievement of 0.79 compared to the average effect of all instruction that contribute to schooling, which was 0.40. Feedback is expected to facilitate learning by increasing learners' awareness of the gaps between their current level of performance and the desired one. This effect seems to depend on the type of feedback provided. Feedback providing information about the task and about how to better execute the task tends to have a more positive effect on learning than feedback based on rewards, praise, or punishment.[10]

However, Kluger and DeNisi,[11] and Kluger and Van Dijk[12] found that providing feedback does not always have the intended positive effect, because it can threaten the learner depending on how it is given. They concluded that a more systematic approach to giving feedback could enhance learning and skill performance while protecting the learner's self-esteem. Their findings echoed those of various authors who developed a more structured form of feedback consisting of an intermediate check of performance against expected performance criteria, accompanied by feedback on observed strengths and weaknesses as well as tips for performance improvement.[11,13,14]

Peer feedback; however, tends to occur in a less formal fashion. Topping[15] suggested that peer feedback could be seen as a formative assessment that supplements the more formal feedback of teachers. It can also be seen as an arrangement structured by a teacher or initiated by learners in order to increase performance.

One of these arrangements is peer-assisted learning (PAL) (i.e., learning support provided to junior students by senior students). While PAL studies have demonstrated that students appreciate feedback from more advanced peers,[16,17] the influence of such feedback on skill acquisition has not yet been investigated.

The influence of peer feedback on future performance has been shown in the area of writing skills, as evidenced by higher performance subsequent to receiving comments from a student of the same level.[18] In a meta-analysis of 123 studies on effective instructions for improving writing skills, Graham and Perin[19] found an effect size of 0.75 for peer assistance. Does peer feedback have the positive impact on medical students? And would PE skills acquisition be influenced by peer feedback?

Norcini[20] is skeptical, because he assumes that peer judgments may suffer from low reliability and validity, which makes them of limited use in fostering learning. Most studies in the medical field have explored the ability of students to accurately assess peer performance, rather than focusing on the effects of peer feedback on student performance. These studies have investigated the reliability and validity of student assessments compared to a gold standard, which is the assessment conducted by teachers.[21,22] The results of these studies carried out in various medical specialties are variable. For example, in studies on psychomotor skills with advanced medical students, 1st-year postgraduate medical residents (PGY1) overrated their peers' performance in comparison to their teachers' marks.[23] Obstetrics and gynecology residents underrated it,[24] whereas the rating was similar to that of experts for general-surgery residents.[25] These studies, however, do not provide evidence of the effects of peer feedback on the performance of learners.

Another potential shortcoming for any real impact of peer feedback on performance is the fact that peer feedback is not

considered as valuable as feedback provided by teachers, who represent the more knowledgeable source.[26,27] On the other hand, despite students' tendency to prefer teachers' comments, peer feedback has been suggested as potentially more effective, because it brings uncertainty, which might encourage reflection of students on their own performance, as demonstrated by Yang et al.[28] while studying the process of writing essays by students. In their study, students had to analyze the value of comments received by a peer before integrating them into their essays. No correlation was found between receptiveness to a specific feedback provider and performance improvement in an academic writing revision task, suggesting that how students view their peers' comments apparently does not affect what they can gain from them.[27]

To summarize, there is some evidence that feedback provided by peers improves performance skills, at least in the area of writing.[28] In medicine, however, the effect of peer feedback on the acquisition of psychomotor skills necessary for PE remains to be demonstrated.

The purpose of the present study was to investigate the effect of peer feedback on the acquisition of psychomotor skills required to perform a PE in a natural learning setting. We define here peer feedback as any information on the quality of performance provided by peers during the learning activity. It was expected that students who learned in an environment that allowed peer feedback would perform significantly better after the learning activity than students who did not receive peer feedback. A secondary objective was to determine if medical students prefer a specific type of feedback provider and, if so, to assess any related impact on the performance of PE skills.

2. Methods

2.1. Setting

The study took place in an undergraduate medical curriculum, which has a four-year problem-based-learning (PBL) curriculum that includes an 18-month clerkship. Clinical-skills training is part of a series of activities within integrated organ-system modules at three different levels: a clinical-skills session during PBL units, a transdisciplinary activity in which students integrate clinical skills related to different organ-based systems previously studied, and several PE practice sessions.[29]

2.2. Participants

The participants were 143 second-year students taking part in a mandatory learning activity to which this study was linked. Ethics approval was obtained at the university where the study was conducted. All participants had to complete a written consent form before taking part in the activity. Out of the original cohort of 143 students, we excluded four who declined to have their data included in the research; two students, who did not show up for the activity; and ten others who participated in dyads due to organizational issues and were not exposed to same peer feedback timeframe.

After initial data analyses, 12 participants were excluded due to missing data (performance was not recorded or information on the number of students in the group was unknown), and three others were excluded because they were extreme outliers. The final analyses were conducted using data from 112 participants.

2.3. Learning task

The study occurred during a learning activity aimed at integrating the neurological PE (taught during the neurology unit) and the lumbar-region PE (taught during the locomotor unit). Students were expected to appropriately integrate the two parts in order to perform the physical examination of a patient presenting with low-back pain. The low-back-pain PE includes the following steps: observation of the patient walking, evaluation of movement amplitude, search for neurological signs, performance of specific manoeuvers to elicit nerve irritation, evaluation of hip and sacroiliac joints and palpation of the lumbar region.

At the end of the learning activity, the students had to master the sequence of the exam, the position to be taken relative to the patient, the handling of the limbs during the sequence, the precision and the force of their palpation, and the signs to be looked for throughout the PE. Once PE skills have been mastered, students are expected to be able to complete the neurolocomotor exam (NLE) in five minutes.

2.4. Procedure

The students were randomly divided into groups of three, and each group was randomly assigned to one of two experimental conditions: peer feedback or no peer feedback. Separate sessions were conducted for each group. Prior to the learning activity, participants answered questions on their preparation for the activity and provided a self-assessment of their ability to perform an NLE. They also answered questions on their preference regarding the type of feedback provider. As five participants did not complete the survey,

the analysis of these questions was conducted with data from 107 participants instead of 112.

The learning-activity session lasted for 1.5 h for each group of three students. It started with an introduction that consisted of watching a video of a teacher performing each step of the NLE. Procedural guidelines were posted on the wall so students could refer to them during the practice phase. After the video, a practice period took place. The first student practised the NLE sequence individually on a standardized-patient instructor (PI) for 15 min, while being observed by the other two students in the group. The second and third students then completed the same sequence individually.

Students who had been assigned to the peer-feedback experimental group were instructed to provide feedback whenever they wanted during the session. PIs were instructed to prompt the students to give feedback at three specific times during the session. In the no-peer-feedback groups, students who observed were asked to remain silent and to simply observe the student who was practising. All the students, independent of the group they were in, received immediate feedback from the PI. Prior to the activity, all four PIs who participated in the study had received extensive training by the principal investigator (BM) on the specific sequences for which they would be providing feedback.

During the assessment phase, each student, in turn, performed the complete NLE sequence alone with the PI. They were allowed five minutes to complete the task. The order of evaluation was the same as the order in which they practised. While one student performed the complete sequence alone with the PI, the two other students went into separate rooms to wait their turn. Each student's performance was videotaped for subsequent assessment.

2.5. Material

2.5.1. Initial survey

The students had to respond to an initial series of seven questions in order to allow for group comparison on (1) the extent to which they had worked with the NLE prior to the study (one question), (2) how much time they had practised or had read about the NLE during the previous week (on a four-point scale: less than 30 min, 30 min to 1 h, 1 h to 2 h, more than 2 h) (two questions), (3) their self-assessment of their ability to perform an NLE (using a 10-point Likert scale), and (4) their interest in feedback from peers and the PI (four-point Likert scale: totally agree to totally disagree) (two questions). One participant did not answer the questions on his preference for feedback provider and five did not complete the entire questionnaire.

2.5.2. NLE performance checklist

We opted for a checklist approach instead of global assessment because it corresponds to the motor skills to be learned by students, allowing for more standardized feedback from the PI. It also makes it possible to specifically identify the skills mastered by the students. Student NLE performance was assessed with a 94-item checklist validated in a previous study.[4] The reliability was good with a Cronbach's alpha of 0.90. In this study, for standardization purposes, two PIs independently rated a sample of seven video-recorded performances, while one PI continued assessing the remaining videos.

Table 1
Characteristics of experimental groups.

Experimental group	Time spent the preceding week	Practice (%)	Reading (%)	Self-assessment	
				Mean	SD
No-peer-feedback group $N=61$	Less than 30 min	83.6	67.2	13.33	3.06
	30–60 min	13.1	27.9		
	1–2 h	3.3	4.9		
	More than 2 h	0	0		
Peer-feedback group $N=46$	Less than 30 min	86.7	65.2	13.39	2.96
	30–60 min	13.3	30.4		
	1–2 h	0	4.3		
	More than 2 h	0	0		

Data are missing for five of the participants (questionnaires were not filled out).
Distribution of students (in percentage) per amount of time spent in practising and reading about the NLE in the preceding week as a function of experimental condition and level of self-assessment prior to the learning activity (out of 20).

For this study, student performance was assessed by a research assistant trained to use the checklist under the supervision of the principal author (BM). Since the patient had to be in the prone position during part of the lumbar exam and since the video could not capture the maneuvers well enough for the research assistant to assess this part, the PIs assessed nine items on the checklist corresponding to the gesture precision.

2.6. Data analysis

To evaluate the comparability of the two groups, the difference in time spent reading or practising the NLE prior to the study was assessed with Pearson's chi-square test. We used a *t*-test to measure the group-wise difference of students being able to assess their own ability to perform the NLE.

For our main objective, a total score was computed for all students to measure performance on the NLE exam. It was obtained by adding all the checklist items; the sum was converted into a percentage score. A *t*-test was performed to check for differences in performance between students in the peer-feedback group and students in the no-peer-feedback group. The data was analyzed with PASW Statistics 18 (SPSS 2009), and the significance level was set at $p < 0.05$ for all comparisons.

In assessing the level of interest in feedback provider, we computed an interest-in-peer-feedback score and an interest-in-patient-instructor-feedback score by adding, respectively, the scores of both questions related to peer feedback and the scores of both questions related to patient-instructor feedback. We performed a repeated-measures ANOVA on these two scores to assess whether the groups were different in their preference and whether, within a group, there were differences between preference for peer feedback or patient-instructor feedback.

3. Results

3.1. Group characteristics

Table 1 presents, on a per-group basis, the students' mean reported preparation for the NLE activity and self-assessment of their ability to perform the NLE. Both groups had previously invested an equal number of hours in practising ($\chi^2(2)=1.51$, $p=0.471$) and reading about the NLE ($\chi^2(2)=0.094$, $p=0.954$) in the previous week. Participants from both groups self-assessed their ability to do the NLE similarly ($t(105)=-0.108$, $p=0.914$).

Table 2
Participants mean NLE performance scores.

Experimental group	*N*	Mean	SD	*p*-Value
No-peer-feedback group	62	87.89	7.41	$p=0.023$
Peer-feedback group	50	90.76	5.31	

Mean scores (%) and standard deviation for each experimental group.

Table 3
Level of interest in feedback providers.

Experimental group	*N*	Interest in PI feedback	Interest in Peer feedback	*p*-Value
No-peer-feedback group	60	7.60 (0.49)	6.37 (0.96)	$p=0.539$
Peer-feedback group	46	7.78 (0.42)	6.35 (1.37)	
p-Value		$p<0.001$		

Data are missing for six of the participants (questions were not filled out).

3.2. Mean NLE performance scores for participants

Table 2 provides the mean total NLE performance scores obtained by the students in the peer-feedback and the no-peer-feedback groups. A *t*-test revealed that performance differed significantly between the two groups—$t(110)=-2.307$, $p=0.023$, $r=0.21$—although the effect size was small.

3.3. Level of interest in feedback provider

Table 3 presents the participants' mean interest-in-peer-feedback score and interest-in-patient-instructor feedback for both groups. There was no significant main effect for the groups: $F(1, 104)=0.380$, $p=0.539$. There was, however, a significant main effect of feedback interest (interest-in-peer feedback vs. interest-in-patient-instructor feedback): students were more interested in PI feedback than in peer feedback: $F(1, 104)=148.24$, $p<0.001$, $=0.588$. The interaction effect was not significant: $F(1, 104)=0.528$, $p=0.360$.

4. Discussion

Martineau et al.[3] and St-Onge et al.[4] have demonstrated that having the opportunity to observe peers while learning PE skills fosters the acquisition of the psychomotor skills required to perform the PE. These studies could not, however, separate the effects of peer observation from

those of feedback. This study investigated the specific influence of peer feedback that often occurs simultaneously with peer observation on the acquisition of the psychomotor skills required to perform an NLE.

We hypothesized that students who learn in an environment that allows for and elicits peer feedback would perform the NLE significantly better than students who did not receive peer feedback through having the opportunity to observe their peers. The findings of the present study confirmed this hypothesis. The participants in the peer-feedback group performed better than the participants who did not have the opportunity to receive peer feedback, although both groups considered PI feedback more useful. Moreover, consonant with the literature, we expected students to be more receptive to teacher feedback than peer feedback.

There is an internal process that occurs subsequent to observation and comments from peers that can explain the impact of peer feedback on the acquisition of PE skills.[6] In this case, peer feedback targeting the correctness of a maneuver or offering suggestions on the next step seem to affect the learner's internal process. The student receiving the feedback must consider and evaluate this information in terms of accuracy and helpfulness, while integrating the result of these considerations into his or her existing level of experience and understanding.

A similar modeling process is also described in the literature regarding the impact of feedback on learning.[10,15] The authors of these studies suggest that learners have to integrate the comments made by teachers or their peers about gaps in performance in order to improve their performance. Thus, they can accept that there is a difference between their performance and the desired level of performance or reject the comments or modulate them in order to achieve an enhanced level of performance.

We did note that the effect size was small. One explanation for this can be the influence of peer observation. Bandura[6] suggests that peer observation is an important source of information for learners. From his perspective and that of other authors, peer observation helps in the acquisition of skills because the peer model is used as a blueprint to enhance performance.[7,8] This blueprint acts as an intermediary model that mirrors the individual's ability in a way that enables the individual to better compare performance. This study afforded both groups the same opportunity to observe their peers, so peer observation cannot explain the difference between the groups.

The higher interest of students for PI feedback may counteract the effect of peer feedback and is another explanation for the small effect size. However, as with peer observation, the difference in interest towards the feedback provider was similar in both groups, so it cannot explain the difference between the groups.

Moreover, Bandura[6] views comments made by peers as exerting a social pressure that modulates the learner's internal process. This type of feedback—verbal or non-verbal—can have a positive or a negative effect, particularly on motivation. This study did not examine the effect of verbal vs. non-verbal feedback. If the non-verbal feedback was perceived positively in the no-feedback group, that could be another explanation for the small effect size of the influence of peer feedback in our study.

The small effect size may also result from the relatively small intervention, that is, peer versus no peer feedback. For all participants, the learning activity included many strategies known to be appropriate for learning psychomotor skills and, consequently, to enhance PE performance: video demonstration of the skills by an expert[5,30] the possibility of practising the skills, PI feedback, and the opportunity to observe peers performing the skills.[3,4] The only difference between our two experimental conditions was the presence/absence of peer feedback. Peer feedback was, therefore, added to all other strategies known to enhance PE performance, which could explain its small effect on learning.

A last possible explanation for the small effect size may be that students were not entirely novices. The learning task was to integrate the neurological and the locomotor parts of the examination previously learned. Greater differences between groups could have been found if the students had been at the beginning of their learning for NLE performance.

4.1. Limitations of this study

Because our study took place in the natural classroom setting rather than in a laboratory, there were some limitations in controlling all the variables. One limitation is that we did not have complete control over the level of feedback provided by PIs. This implies that the amount and the quality of PI feedback may have varied across the groups. Furthermore, we did not have strict control over student adherence to the research protocol and instructions that specified that participants in the no-peer-feedback group should remain silent when observing their peers.

A possible drawback of the study was the use of a detailed grid instead of global ratings to assess the students' performance. Our choice was motivated by the fact that detailed assessment of performance allows

for better identification of the different psychomotor-skill components in the NLE. The checklist therefore corresponds to the feedback provided by PIs during the learning phase. Furthermore, this checklist was used and validated in a previous study.[4] While we could find differences between students, the global ratings had a different purpose. They have been used to reliably assess complex competences in surgery[31] with a view towards better discriminating between different levels of expertize.[32]

To better understand the effects of peer feedback, future studies should consider investigating the quality and the quantity of peer feedback required to make a difference while learning PE skills. Many factors related to the feedback provided by peers, such as the type of peer feedback, the content addressed, the level of interest, and the accuracy of comments made by peers, have to be assessed. Such studies would contribute to a better understanding of the role of peer feedback in the acquisition of the psychomotor skills necessary for performing an adequate PE.

5. Conclusion

This study, conducted in a naturalistic environment, demonstrated the positive effect of peer feedback on learning skills required to perform an NLE and its potential role in helping medical students improve their PE performance. Peer feedback seems to complement other learning strategies such as video demonstrations by experts, PI feedback, and peer observation in supporting students while they learn the correct procedures for performing a PE. As group activities for PE learning are used in many medical-school curricula, instructions such as telling students to provide feedback to their peers might help students better acquire the motor skills necessary for the PE. For these reasons, peer feedback should be encouraged during PE learning sessions.

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