

Dependence of Learning of a Soccer Skill on the Environmental Light Condition: Examining the Specificity of Practice

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ABSTRACT

Objective: The study aimed to investigate the specificity of practice hypothesis in soccer by examining the impact of environmental light conditions on the learning of a soccer push pass. Specifically, it sought to determine whether practicing under natural or artificial light would influence skill acquisition and transfer when visual conditions changed.

Method: Twenty-six male students (mean age 20.67 ± 1.78 years) with no prior experience in the experimental task were matched and divided into two practice groups based on their pre-test scores in the Mor-Christian Push Pass Test. One group trained under natural sunlight (daytime), while the other practiced under artificial gym light (nighttime) for six sessions (three times per week). Following the training phase, participants underwent immediate retention tests under the same light conditions as their practice. A delayed retention test was conducted ten days later. Data were analyzed using a 2 (group: natural vs. artificial light) $\times$ 2 (test condition: natural vs. artificial light) $\times$ 2 (test delay: immediate vs. delayed) repeated measures ANOVA via SPSS-16.

Results: The results revealed no significant differences in skill acquisition between the two practice groups during training. However, during transfer tests where light conditions were altered, both groups exhibited a significant decline in performance. This finding supports the specificity of practice hypothesis, indicating that skill learning is context-dependent and performance deteriorates when environmental conditions change.

Conclusions: The study confirms that soccer push pass performance is sensitive to the environmental context in which it is practiced. While both natural and artificial light conditions yielded similar skill acquisition, the inability to maintain performance under altered lighting suggests that practice specificity plays a critical role in motor learning. These findings highlight the importance of training under varied conditions to enhance adaptability and transferability of sport skills.

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Introduction

The main aim of motor behavior specialists and sport psychologists is help athletes achieve their highest performance under varied conditions, often through optimal training methods (1). One of the most important findings in learning research is the "specificity effect", suggesting that performance in test conditions has the highest probability of being optimized if test conditions are similar to the conditions in which a skill was practiced. The term with close meaning to specificity effect in the context of motor control is "specificity of practice," first introduced to the motor behavior field by Henry (2, 3). Proteau, Marteniuk, Girouard, and Dugas (1987) pioneered experimental studies in this area. In their first experiment, they asked four groups of participants to practice an aiming task under two visual conditions for 200 and 2000 trials. Results showed that participants' dependence on vision increased as a function of length of practice with vision (4).

Investigators have widely replicated the specificity of practice effect across a wide variety of motor tasks including manual and video aiming (5-10), key typing (11) powerlifting (12), ball interception (13, 14), baseball batting (15), locomotion (16), basketball free throw (1), and leg positioning recall (17). In studies evaluating the effect of exercise on motor skills, participants are asked to practice a specific motor task under a specific condition, and then carry out the task in transfer test(s) under the same or a new condition. In some studies in this field, the researchers provide a situation in which the task or the extremity performing the task is in (or out of) sight of the participants. The results demonstrated that the most effective performance is usually achieved when the conditions of the transfer tests are similar to those of the training sessions.

On the other hand, the specificity of practice hypothesis has failed to obtain support from investigations of gross motor skills such as power lifting (18), beam walking (19, 20), and one-handed ball catching (21, 22).

Robertson et al. (1994) showed that elite gymnasts were less dependent on visual feedback information comparing with novice athletes. They reported that it took elite gymnasts the same time to walk on the balance beam either with or without vision. However, novice gymnasts needed more time to walk across the beam in no-vision conditions. These findings suggest that experienced gymnasts use other sources of sensory information for this movement (19). In studies that did not support the specificity of practice hypothesis, participants engaged in tasks for which performance did not rely heavily on visual information. Proteau and colleagues (1998) reported that these participants used more proprioceptive feedback (23). Concerning the Robertson and colleagues' study (1994), most gymnasts try to practice walking on the balance beam with their eyes closed, increasing awareness of sensory feedback from kinesthetic and/or vestibular signals so that later manipulations of visual information do not impair their performance (19). New studies findings in physical education including Chanal and Paumier (2025) indicated that intrinsic motivation and identified regulation accounted for a higher proportion of activity-specific variance than controlled motivations in a completely new domain. This study supports the Specificity Hypothesis in the Physical Education context, indicating that autonomous motivational regulations are more specific to physical activities than controlled regulations. Also, specificity of motivational regulations varies across physical activities, with football exhibiting the highest specificity (24). Moreover, a research results in children domain provide evidence for specificity

rather than generality in learning motor skills a viewpoint that has predominantly been driven by adult learning studies (25). Boeve et al., (2024) examined the domain specificity of motor contributions in auditory statistical learning and suggested that the speech motor system contributes to auditory statistical learning in a highly specific manner (26).

Most studies carried out in the field of practice specificity hypothesis have used laboratory tasks, hardly generalizable to real conditions. Due to the challenges that existed in previous studies, in this study, we tested the specificity of practice hypothesis in a gross motor skill and real-world conditions that changes in environment light conditions occur naturally. Soccer is such that some of the competitions held at day and sunlight (natural light) and some other competitions will be held at night and gym light (artificial light) conditions. We were interested in to examine the learning of soccer push pass in both natural and artificial light conditions. Light conditions (day and night) can be an important factor to affect performance in gym and sport places. Is the transfer participants to the new training conditions (natural and artificial light) can be dropped the performance in accordance with specificity of practice hypothesis?

Materials and Method

Participants

According to past studies, 26 male students with mean age 20.67 ± 1.78 , without any previous history of playing soccer or being familiar with the skills of the sport participated in the study. The participants did not have visual problems (except corrected vision with glasses) and participate in the study voluntarily (after obtaining a written consent).

Experimental Task

Skill test battery of Mor-Christian Push Pass Test was used as the Experimental Task. A goal 1 yard wide and 18 inches high is prepared by placing two cones 1 yard apart with a 4-foot rope used as a cross-bar. Two cones are placed at a 45-degree angle from the goal line, and one cone is placed at a 90-degree angle from the goal line. All three cones are located 15 yards from the goal. One point is awarded for each successful pass. Balls that hit the goal cones considered successful. The final score is the total of 12 pass trials. For passing test, coefficients of .78 and .96 were reported for validity and reliability, respectively (27).

Procedure

Before any intervention, an introductory session was held where a skilled coach explained passing skill to the subjects. The scoring procedure was also elaborated by one of the researchers (second author). Subjects practiced the criterion skill, Mor-Christian Push Pass, for 15 minutes. After trials of each participants, the coach gave two feedback to the each participant about their performances. The pre-test was conducted at the end of the introductory session and the subjects were matched and divided into two groups ($n_1=n_2=13$) according to their pre-test score. The independent variable was scores obtained by participants in performing Mor-Christian Push Pass Test. In pre-test, each participant performs 12 trials of passing skill (four passes from each angle) (27). Afterwards, group A practiced passing skill under sunlight (day time) and group B practiced under gym light (night time). The spend time for each participant's pre-and-post-test was 12 minuts, approximately. In other words, The group A practiced under natural light conditions at 5 pm and group B practiced under artificial light conditions at 7 pm. The participants in both groups practiced the task (60 trails in each session: 15 trials from each angle as variable practice) for 6

sessions. The practice was done three sessions in a week for 2 weeks. All the conditions of skill acquisition except the court light were the same for both groups. Two hours after the last session, post-test under same light condition were taken.

24 hours after the last session, post-test (under natural light and artificial light) were taken. Ten days later, similarly, the delayed tests were taken at 5 pm and 7 pm for natural and artificial light respectively. The tests were carried out under conditions similar to practice sessions, with the difference that the participants did not receive any augmented feedback on their performances and their scores. The tests were first conducted in natural light and then in artificial light so that it was considered as a retention test for one group but transfer test for another one. In transfer tests, the participants who had practiced the task under natural light were transferred to artificial light and those who had practiced under artificial light were transferred to natural light. In test phase, in order to avoid the warm-up decrement, the participants made six passes (two passes from each angle) under the same light condition and then took the test.

Statistical Analysis

We used independent sample t tests to assess group differences at baseline. To evaluate the participants' performance in acquisition phase and compare the performance of participants on pre-test and post-test in two groups, paired t test was used. To analyze the data in the test phase, we use a 2 (group: natural vs. artificial light) $\times$ 2 (test condition: natural vs. artificial light) $\times$ 2 (test delay: immediate vs. delayed) ANOVA with repeated measures on the last two factors. All statistical operation performed by SPSS-16 software.

Results

At baseline, independent t test revealed no significant differences in mean task scores between the two study groups, $t(26) = 0.11$, $p = .91$. We used paired t-test for comparing the effect of practice sessions for the participants assigned to each group in pre-test and post-test. In natural light condition, result showed significant statistical difference between the mean scores of pre and post-tests, $t(12) = -15.06$, $p < .001$. As well as in artificial light condition, result showed significant statistical difference between the mean scores of pre and post-test, $t(12) = -14.02$, $p < .001$. In the test phase, data were analyzed with a 2 (training condition: natural vs. artificial light) $\times$ 2 (test condition: natural vs. artificial light) $\times$ 2 (test delay: immediate vs. delayed) Mixed design ANOVA with repeated measures on the last two factors. The results showed that main effects of the training condition, $F(1, 24) = 0.41$, $p = .52$, Partial $\eta^2 = .017$, and test condition, $F(1, 24) < 1$, $p = .82$, Partial $\eta^2 = .002$ were not significant. There was a significant interaction effect between the training condition and the test condition, $F(1, 24) = 295.72$, $p < .001$, Partial $\eta^2 = .92$. This indicates that light test condition had different effects on the learners' scores depending on which type of training condition was used. In the analysis, main effect of the test delay was significant, $F(1, 24) = 4.33$, $p = .04$, Partial $\eta^2 = .15$, but interaction effect between the training condition and the test delay, $F(1, 24) < 1$, $p = .71$, Partial $\eta^2 = .006$, and interaction effect between the training condition, test delay and test condition, $F(1, 24) < 1$, $p = .35$, Partial $\eta^2 = .03$, were not significant. The performance of the two groups in acquisition and test phases demonstrated in Figure 1.

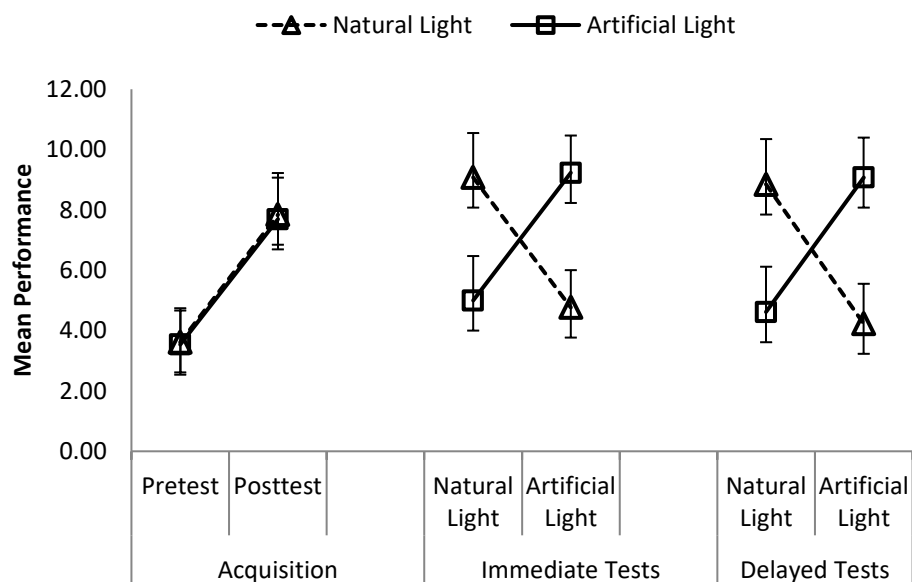


FIGURE 1. Mean performance of the two groups in acquisition and test phases.

Discussion

In previous studies, the specificity of practice hypothesis was confirmed in basketball free throw skill, but target only visual condition does not occur in real condition of basketball sport. In soccer, athletes often practice in day and under sunlight (natural light) in condition, while some matches are held at night and under gym light (artificial light) condition. The main purpose of the present study was to examine the specificity of practice hypothesis in a real sport condition. Analysis of the scores obtained by participants in passing test demonstrated that the two groups improved equally in acquisition phase. The performance of participants did not decrease in the immediate retention test given under the visual conditions they experienced, while the performance score of both groups decreased somewhat in delayed retention tests. This finding indicates that part of the obtained scores by participants in the immediate retention tests was due to the effect of temporary variables. Nevertheless, when the light conditions changed, the

performance scores of the two groups was decreased in immediate and delayed tests. Our findings support the specificity of practice hypothesis.

In acquisition phase, the results showed that participants in both groups improved equally in performance of the passing skill. Participant of experimental and control groups in post-test were significantly better than pre-test. Moradi et al (2014) stated that lack of difference in acquisition between the two groups can probably be attributed to the fact that participants of both groups were asked to employ their peripheral visual system for motor control (28). Peripheral vision is specific to motor control and is not sensitive to the light in the environment (29).

The main finding of this study was the significant decrease in performance scores of the two groups on immediate and delayed transfer tests by changing visual conditions. Probably, participants became dependent on the environmental information and visual conditions in practice sessions. Therefore, when the visual condition changed, the performance of the participants deteriorated

significantly. These findings supported specificity of practice hypothesis and were consistent with previous works (4, 14, 28, 30, 31).

Proteau and colleagues proposed that learning is specific to the sources of sensory information available during practice. In another justification for the specificity of practice, Proteau (1992) stated that during the early stages of practice, separate sensory stores exist for vision and proprioception. When one source of sensory information was removed, participants could still rely on the other source of feedback. As learning progresses, vision and proprioception are integrated to form an intermodal representation of the expected sensory consequences, thereby mediating a shift from intramodal to intermodal sensory processing. At this point, the withdrawal of one source of information would cause performance to deteriorate because the incoming sensory information can no longer be compared to the single integrated sensory store (32).

Recently, Toussaint, Meugnot, Badets, Chesnet, Proteau (2017) examined the specificity of practice hypothesis in goal-directed movements. They wanted to examine whether modifying the proprioceptive feedback would decrease the dominance of visual feedback. Participants performed leg positioning recall task with both vision and proprioception or proprioception only, under either a natural or a modified proprioception condition. In transfer test, participants performed with proprioception only. In acquisition, the performance was significantly better in conditions with both vision and proprioception, but in transfer when vision was withdrawn, the recall error was increased significantly. These results confirmed the specificity of practice hypothesis (17). In some findings of non-motor skills studies including Chanal and Paumier (2025),

Sigmundsson et al., (2021), and Boeve et al., (2024) confirmed the specificity hypothesis (24-26).

The results of this study along with Chanal and Paumier (2025), Sigmundsson et al., (2021), and Boeve et al., (2024) showed that the specificity of practice hypothesis confirmed not only in laboratory tasks but also in real tasks. These results were similar to those obtained in manual aiming task and showed that the 'specificity of practice hypothesis' also holds for gross motor skills. Previous studies had shown that there are challenges about the specificity of practice hypothesis in real tasks. Most of these challenges stem from research on gross motor skill and expert–novice differences. For example in one-handed ball catching task, Whiting and Savelsbergh (1992) showed that performance of the participants did not drop when participants were provided with vision of the hand after training without vision of the hand. Whiting and Savelsbergh (1992) stated that performance in a vision transfer test was similar for participants who practiced with vision of the hand and those who had practiced without vision of the hand (21). In response to this evidence against the specificity of practice hypothesis, Tremblay and Proteau (2001) noted that in ball catching studies, participants receive KR about whether or not they have caught the ball from information derived from ball/hand contact (13). In some re-examination researches of whether the specificity of practice hypothesis holds for 'real-world' tasks, Tremblay and Proteau (1998) changed research methodology and concluded that practice specificity hypothesis is valid for such tasks (12). Therefore, in order to test specificity of practice, it is better to have more control over the sensory information during practice. Some of our research limitations such as time of testing, age of participants, and level of skill can be considered in future studies.

Generally, the results of this study showed that the specificity of practice hypothesis also confirmed in a field sport skill as gross motor skill. Probably practicing soccer skills under natural light, to be followed the best performance under the same conditions. Sometimes in soccer, matches will be held in light conditions which are not similar to light practice conditions. According to the results of this study athletic performance in these conditions deteriorates. Therefore, it is recommended to coaches that try to same training conditions as much as possible to competition conditions.

Conclusion

Generally, the results of this study showed that the specificity of practice hypothesis also confirmed in a field sport skill as gross motor skill. Probably practicing soccer skills under natural light, to be followed the best performance under the same conditions. Sometimes in soccer, matches will be held in light conditions which are not similar to light practice conditions. According to the results of this study athletic performance in these conditions deteriorates. Therefore, it is recommended to coaches that try to same training conditions as much as possible to competition conditions.

Author contributions

Author contributed to the conceptualization of the article and writing of the original and subsequent drafts.

Data Availability Statement

Data available on request from the authors.

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Ethical Considerations

All ethical principles are considered in this article. The ethical principles observed in the article, such as the informed consent of the participants, the confidentiality of information, the permission of the participants to cancel their participation in the research. Ethical approval was obtained from the Research Ethics Committee of the Arak University.

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Conflict of interest

The authors declared no conflict of interest.

References

1. Bennett S, Davids K. The manipulation of vision during the powerlift squat: Exploring the boundaries of the specificity of learning hypothesis. *Research Quarterly for Exercise and sport*. 1995;66(3):210-8.
2. Khan MA, Franks IM. The utilization of visual feedback in the acquisition of motor skills. *Skill acquisition in sport: Research, theory and practice*. 2004:121-44.
3. Krigolson O, Van Gyn G, Tremblay L, Heath M. Is there "feedback" during visual imagery? Evidence from a specificity of practice paradigm. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale*. 2006;60(1):24.
4. Krigolson OE, Tremblay L. The amount of practice really matters: Specificity of practice may be valid only after sufficient practice. *Research quarterly for exercise and sport*. 2009;80(2):197-204.
5. Mackrour I, Proteau L. Specificity of practice results from differences in movement

- planning strategies. *Experimental Brain Research*. 2007;183(2):181-93.
6. Moradi J, Movahedi A, Salehi H. Specificity of learning a sport skill to the visual condition of acquisition. *Journal of motor behavior*. 2014;46(1):17-23.
 7. Movahedi A, Sheikh M, Bagherzadeh F, Hemayattalab R, Ashayeri H. A practice-specificity-based model of arousal for achieving peak performance. *Journal of motor behavior*. 2007;39(6):457-62.
 8. Proteau L, Carnahan H. What causes specificity of practice in a manual aiming movement: Vision dominance or transformation errors? *Journal of Motor Behavior*. 2001;33(3):226-34.
 9. Proteau L, Isabelle G. On the role of visual afferent information for the control of aiming movements toward targets of different sizes. *Journal of Motor Behavior*. 2002;34(4):367-84.
 10. Proteau L, Marteniuk RG, Girouard Y, Dugas C. On the type of information used to control and learn an aiming movement after moderate and extensive training. *Human Movement Science*. 1987;6(2):181-99.
 11. Proteau L, Marteniuk RG, Lévesque L. A sensorimotor basis for motor learning: Evidence indicating specificity of practice. *The Quarterly Journal of Experimental Psychology*. 1992;44(3):557-75.
 12. Proteau L, Tremblay L, Dejaeger D. Practice does not diminish the role of visual information in on-line control of a precision walking task: Support for the specificity of practice hypothesis. *Journal of Motor Behavior*. 1998;30(2):143-50.
 13. Proteau L. Visual afferent information dominates other sources of afferent information during mixed practice of a video-aiming task. *Experimental Brain Research*. 2005;161(4):441-56.
 14. Robertson S, Collins J, Elliott D, Starkes J. The influence of skill and intermittent vision on dynamic balance. *Journal of Motor Behavior*. 1994;26(4):333-9.
 15. Robertson S, Elliott D. Specificity of learning and dynamic balance. *Research Quarterly for Exercise and Sport*. 1996;67(1):69-75.
 16. Robin C, Toussaint L, Blandin Y, Proteau L. Specificity of learning in a video-aiming task: modifying the salience of dynamic visual cues. *Journal of Motor Behavior*. 2005;37(5):367-76.
 17. Schmidt RA, Lee TD. *Motor control and learning: A behavioral emphasis*. 5th ed: Human Kinetics Publishers; 2011 March 30, 2011.
 18. Scott SA, Gray RD. Specificity of practice in baseball batting. *Journal of Sport & Exercise Psychology*. 2007;29.
 19. Soucy M-C, Proteau L. Development of multiple movement representations with practice: Specificity versus flexibility. *Journal of motor behavior*. 2001;33(3):243-54.
 20. Strand BN, Wilson R. *Assessing sport skills* 1993.
 21. Toussaint L, Meugnot A, Badets A, Chesnet D, Proteau L. The specificity of practice hypothesis in goal-directed movements: visual dominance or proprioception neglect? *Psychological research*. 2017;81(2):407-14.
 22. Tremblay L, Proteau L. Specificity of practice in a ball interception task. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale*. 2001;55(3):207.
 23. Tremblay L, Proteau L. Specificity of practice: The case of powerlifting. *Research quarterly for exercise and sport*. 1998;69(3):284-9.
 24. Tremblay L, Welsh TN, Elliott D. Specificity versus variability: Effects of practice conditions on the use of afferent information for manual aiming. *Motor Control*. 2001;5(4):347-60.
 25. Whiting H, Savelsbergh G, Pijpers J. Specificity of motor learning does not deny flexibility. *Applied Psychology*. 1995;44(4):315-32.
 26. Whiting H, Savelsbergh G. An exception that proves the rule! In: Stelmach GE, Requin J, editors. *Tutorials in motor behavior II* (pp 583-579). Amsterdam, the Netherlands: North-Holland. 1992.

27. Wright DL, Shea CH. Contextual dependencies in motor skills. *Memory & Cognition*. 1991;19(4):361-70.
28. Yoshida M, Cauraugh JH, Chow JW. Specificity of practice, visual information, and intersegmental dynamics in rapid-aiming limb movements. *Journal of Motor Behavior*. 2004;36(3):281-90.
29. Sigmundsson H, Newell KM, Polman R and Haga M. (2021). Exploration of the Specificity of Motor Skills Hypothesis in 7–8 Year Old Primary School Children: Exploring the Relationship Between 12 Different Motor Skills From Two Different Motor Competence Test Batteries. *Front. Psychol.* 12:631175. <https://doi.org/10.3389/fpsyg.2021.631175>
30. Chanal J and Paumier D. The specificity hypothesis in physical education: Investigating differentiation of motivational regulations across activities and their links to self-concept. *Psychology of Sport & Exercise*. 2025; 80: 1-8. <https://doi.org/10.1016/j.psychsport.2025.102936>