1    Running head: Practice and augmented feedback on Netball

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3    Augmented feedback over a short period of time: Does it improve netball goal shooting

4    performance?*

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45                                             Abstract

46            The aim of the present study was to evaluate the effect of practice and augmented

47      feedback on a complex motor skill (netball goal-shooting) on an indoor netball court, without

48      restricting the interaction time between the learner and the instructor. Thirty participants were

49      randomly allocated into a control (CON), practice (PRA), or practice with augmented

50      feedback group (AUG), and completed 20 netball goal-shots at pre- and post-practice testing

51      sessions. PRA and AUG participated in 3 consecutive practice sessions lasting 20 minutes

52      each. In addition, the AUG group received goal-shooting instructions. The AUG group

53      showed a significant greater improvement in scoring performance compared to CON and

54      PRA, which highlights the importance of augmented feedback in the acquisition of complex

55      motor skills. The current study provides a bridging step between laboratory motor learning

56      and applied research.

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58      Keywords: verbal cues, skill acquisition, beginners

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61       Augmented feedback provision over a short period of time: Does it improve netball goal

62                                    shooting performance?

63       Augmented feedback is the information that a learner does not normally receive directly

64   from their senses (Lee, Swinnen & Serrien, 1994) and is usually delivered by external sources

65   using verbal cues (Landin, 1994). It can be given during (concurrent) and/or after (terminal)

66   performance. The information provided concerns (a) the outcome of performance (the action

67   outcome), usually termed knowledge of results (KR), and/or (b) the movement characteristics

68   (the action pattern), usually termed knowledge of performance (KP). Augmented feedback

69   has been extensively studied within the field of motor learning research and has been found to

70   be a key tool in learning and improving motor skills (for reviews see Schmidt & Wrisberg,

71   2004; Wulf & Shea, 2004).

72       Evidence exists that KR and KP together enhance performance (e.g., Viitasalo, Era,

73   Konttinen, et al., 2001). It has also been shown that KR alone can be more effective than KP

74   alone (e.g., Tzetzis, Kioumoutrzoglou & Mavromatis, 1997), and vice versa (e.g., Zubiaur,

75   Oña & Delgado, 1999). These equivocal results may be attributed to the characteristics of the

76   skill itself and/or the learner (Magill, 1994); accuracy requirements imposed by the task

77   (Reeve, Dornier & Weeks, 1990); age, experience and types of feedback (Amorose & Smith,

78   2003); instructional strategies (Boyce, 1991); and motivational orientation of the learners

79   (Little & McCullagh, 1989).

80       Although previous studies have fully achieved their aims, little attention has been given

81   to both the field restraints of the methodologies used and the practical implementations of the

82   findings reported. Most studies (a) used tasks, such as the Tower of Hanoi puzzle cognitive

83   complex problem solving (Fredenburg, Lee & Solmon, 2001); (b) were laboratory based

84   (McCullagh & Little, 1990); and (c) used a different and wide range of intervention durations

85    (Reeve et al., 1990; Winstein, Pohl & Lezthwaite, 1994; Zubiaur et al., 1999). As a result, the

86    application of the knowledge gained from this nature of research has had limited

87    transferability into situations where skill instruction occurs (Boyce, 1991). As first suggested

88    by Christina (1987) and later by Silverman (1994), there is an inevitable trade-off between

89    internal and external validity as we move from the laboratory and motor learning research

90    towards applied research.

91        This lack of external validity revolves around the specificity of the tasks employed, the

92    experimental settings utilized, and time-related issues. Firstly, with regard to the task

93    employed when investigating the effects of KR in motor skill acquisition, McCullagh and

94    Little (1990) employed a task consisting of displacing seven vertical barriers with the right

95    hand moving through a prescribed pattern in 2,100 msec. This timing task has no real

96    resemblance to a typical athletic skill.

97        Secondly, in relation to the experimental settings utilized, Todorov, Shadmehr and Bizzi

98    (1997) used a virtual environment to demonstrate the positive effect of training with a specific

99    form of augmented feedback on the performance of a multijoint movement shot in table

100   tennis. During training a computer displayed a realistic three-dimensional simulation of the

101   environment consisting of a graphical representation of the experimental set-up, the

102   participants and model's paddles (with electromagnetic sensors attached to enable tracking of

103   the position and orientation from them), and the ball. Although the use of such technology

104   would enhance the quality of the feedback provided to learners, a similar high-technology

105   experimental set-up would be practically impossible to utilize in a traditional environment

106   where Physical Education (PE) and/or sport are delivered.

107       Finally, past research has not systematically considered time-related issues. Studies have

108   expanded over prolonged (Tzetzis et al., 1997), short (McCullagh & Little, 1990; Reeve et al.,

109   1990) or non-specified (Winstein et al., 1994) periods of time. More specifically the length of

110    contact time with learners and the time constraints imposed on the execution of the

111    performance under investigation have limited the ability to generalize the findings.

112         In relation to the length of the contact time with learners, Williams, Ward and Chapman

113    (2003) investigated the transfer of goalkeepers' anticipation skills at the penalty flick from

114    laboratory-based setting to the game of field hockey. The actual individualized feedback

115    provision (45 minutes on an individual basis) is probably unrealistic for most sporting

116    situations, due to the time commitment required from the instructor. With regard to the time

117    constraints imposed on the execution of the performance, Zubiaur and colleagues (1999)

118    restricted the time lapse between the performance of a volleyball serve and the presentation of

119    the feedback after the ball hit the ground, and the interval between serves (5 and 25 sec.,

120    respectively). Similar artificial time constraints are not found in natural sporting situations.

121         Establishing the influence of practice and augmented feedback on motor skill

122    acquisition, while attempting to address the abovementioned constraints, is of practical value

123    to physical educators and coaches. Therefore, the aim of the present study was to evaluate the

124    effect of practice and augmented feedback on performance of a complex motor skill (i.e.,

125    netball goal-shooting). The assessment was carried out on an indoor netball court without

126    restricting the interaction time between the learner and the instructor.

127                                            Methods

128    *Participants*

129         Participants were 30 young adults (male = 12, female = 18; age $M$ = 21.8 yrs, $SD$ = 2.4

130    yrs) with some experience in goal-shooting activities; however, they had not practiced these

131    type of activities (e.g., netball, basketball) for at least 2 years prior the experiment.

132    Participants signed an informed consent form but were unaware of the purpose of the study,

133    and were randomly allocated into a control (CON; 3 male, 7 female), practice (PRA; 7 male,

134    3 female), or practice with augmented feedback group (AUG; 1 male, 9 female).

135    *Procedure*

136        Testing and practice took place on an indoor netball court over a blocked schedule of a

137    five-day period. All participants attended, on an individual basis, pre- and post-practice

138    testing sessions on the first and last day of the 5 days, respectively. At the pre-practice testing

139    session, participants were provided with an introductory description and demonstration of the

140    appropriate netball goal-shooting technique. In addition, both at pre- and post-practice testing

141    sessions, participants were given practice trials to allow familiarization with the task, ball, and

142    shooting distance, before the actual testing commenced. Twenty netball goal-shots were

143    executed from a standard goal-shooting position (2 meters away and directly opposite to a

144    standard 3.05 meters high netball post).

145        The practice sessions for the PRA and AUG groups took place on three consecutive

146    days (days 2-4). Following Shakespear's (1997) suggestions on practicing netball goal-

147    shooting, each practice session lasted 20 minutes. Participants attended the practice sessions

148    on an individual basis. A flexible time interval between shots was permitted to allow

149    participants to choose their own shooting pace freely. Additionally, the AUG group received

150    instructions (i.e., augmented feedback) from a Level 3 qualified netball coach[1]. The coach

151    was selected due to her experience in coaching netball and educational background in PE.

152        The provision of augmented feedback followed Chen's (2001) general suggestions for

153    practitioners and Shakespear's (1997) specific instructions for netball goal-shooting. A

154    loosely structured rather than scripted feedback was adopted (Hebert & Landin, 1994); each

155    participant was informed by the instructor of the appropriate correction after each error.

156    Verbal cues were employed to help participants focus their attention on the key aspects of

157    their goal-shooting technique (Landin, 1994). Depending on the margin of the error, the

158    instructions would focus on either general or specific technical flaws. For example, statements

159    may have been, "Good effort, now you try to extend your legs before releasing the ball" for a

160    short shot, or "Good shot, next time make sure you follow through the shot until all fingers

161    point to the ground" for a skewed shot (Shakespear, 1997).

162         An objective rating system was employed to record the scores achieved at pre- and post-

163    practice testing sessions, similar to that utilised by Tzetzis and colleagues (1997). For each

164    shot, participants in the current study received zero points if they missed completely, two

165    points if they hit the goal-ring of the netball post, and five points if they scored. Therefore, the

166    maximum points any participant could achieve were 100. Participants were required to follow

167    the appropriate netball goal-shooting technique demonstrated by the instructor at the pre-

168    practice testing session.

169    *Statistical analyses*

170         Normality of the data was examined using the Kolmogorov-Smirnov test and

171    subsequently confirmed. A one-way Analysis of Variance (ANOVA) was carried out to

172    examine whether the goal-shooting performance was influenced by the gender of the

173    participants, in both the pre- and post-practice testing sessions.

174         The effect of the intervention on the total score was analyzed using a 3 (Groups; CON,

175    PRA, AUG) x 2 (Measurements; pre-test, post-test) MANOVA, followed by Tukey's *post-*

176    *hoc* when differences were found. Homogeneity of the data was examined first using

177    Levene's test, and secondly Box's test (Field, 2005). The significance level was set at $p < .05$.

178                                         Results

179         One-way ANOVA showed no differences between females and males in pre-practice

180    ($F(1, 28) = 3.14$, $p = .087$; females: $M = 53.89$, $SD = 12.3$ points, males: $M. = 46.33$, $SD = 9.9$

181    points) and post-practice ($F(1, 28) = .241$, $p = .627$; females: $M = 62.72$, $SD = 12.4$ points,

182    males: $M. = 60.5$, $SD = 11.6$ points) training session scores. Therefore, the data was collapsed

183    for gender for the remaining analyses.

184    Levene's test (pre-practice: $F(2, 27) = 0.274$, $p = .763$; post-practice: $F(2, 27) = 0.951$, $p$

185    $= .399$) and Box's test ($F(6, 18169.0) = 0.606$, $p = .726$) verified the homogeneity of the data.

186    MANOVA revealed a significant effect ($F(2, 27) = 4.048$, $p = .029$). Univariate analysis

187    showed no significant difference ($F(2, 27) = .714$, $p = .499$) in the pre-practice testing session

188    scores but did reveal a significant difference ($F(2, 27) = 3.72$, $p = .037$) in the post-practice

189    testing session scores (see Table 1 for descriptive data). Further Tukey's *post-hoc* analysis

190    showed a significant difference between CON and AUG only ($p = .035$).

191                                                    Discussion

192    The present study examined the effect a brief instructional intervention had on netball

193    goal-shooting performance, without restricting the interaction time between the learner and

194    the instructor. The results showed that the participants in the AUG group improved their

195    performance over the 3 training sessions compared to the CON and PRA groups. This finding

196    supports the salient role of augmented feedback in the acquisition of complex motor skills

197    (Schmidt & Wrisberg, 2004; Wulf & Shea, 2004).

198    Findings related to the role of feedback and verbal instruction in the early motor

199    learning stages remain inconclusive (Wulf & Shea, 2004). Past research has shown that the

200    combination of KR and KP is a key tool in learning and improving motor skills (Schmidt &

201    Wrisberg, 2004), yielding greater results than practice alone (Hebert & Landin, 1994;

202    Viitasalo et al., 2001). On the contrary, Magill (1994) stated that the learning of a complex

203    motor skill does not necessarily benefit from the provision of augmented feedback any more

204    than simply practicing the skill. Additionally, Hebert and Landin (1994) suggested that verbal

205    feedback does not have an immediate impact on performance outcomes. Our findings support

206    the view that the combination of KR and KP had a positive impact on the acquisition of

207    complex motor skills (Cooper & Rothstein, 1981; Kernodle & Carlton, 1992).

208    In the current study, a short intervention period was sufficient for beginners to develop

209    physical competence of a complex motor skill, through practice with augmented feedback.

210    The impact the brief intervention had on the examined athletic action reinforces the necessity

211    for instruction and feedback during practice sessions. Although time-related constraints (e.g.,

212    50 minutes PE lesson) pose difficulties for practitioners to provide enough feedback to all

213    learners, it is important for them to recognize that feedback impacts on the acquisition of

214    complex skills. This finding highlights the need for policy initiatives to promote more practice

215    time within PE and sporting activities. For example, in the UK, all schools must provide a

216    minimum of 2 hours for PE and sport within curriculum to all children, which was not

217    previously the case (CCPR, 2005).

218    Boyce (1991) suggested that motor skill learning studies had not utilized sports skills,

219    nor had they been conducted in field-based settings. A decade later, Hodges and Franks

220    (2002) stated that the validity of previous laboratory-based findings had still not been verified

221    in more applied settings. The current study, although not fully enabling us to understand

222    motor skill teaching/learning, attempted to maintain a balance on the motor learning

223    continuum (Christina, 1987) to fill an acknowledged gap in the field of motor skill

224    acquisition. Hence, the study aimed to provide a bridging step between laboratory motor

225    learning research and applied research (Silverman, 1994) by not restricting the time allowed

226    for interaction between the learner and the instructor during practice, on the netball court.

227    However, future research should "*preserve the integrity of the teaching/learning*

228    *environment*" further (Boyce, 1991, p. 55) by investigating feedback to a group *vs.* an

229    individual only. Also, researchers should consider the learner-instructor interaction (e.g., in a

230    PE setting; Koka & Hein, 2005) as well as the psychological aspects that affect such

231    interaction (e.g., motivation, goal orientation, perceived competence; Standage & Treasure,

232    2002) and the effect of practice and feedback on skill retention (Lee et al., 1994).

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305      *89*, 223-232.

306                                    Footnotes

307    1. Holders of England Netball Level 3 Coaching Certificate ("County Coach Award") possess

308    both theoretical knowledge and practical experience in netball coaching. This enables them to

309    help groups of beginners to play and practice in a safe and enjoyable environment, by setting

310    meaningful learning and coaching situations (see England Netball, 2000, for further details).

311

312    Table 1. Descriptive Data for the Scores of the Three Groups at Pre- and Post-Practice Testing

313    Sessions

|  | Pre-practice testing scores | | Post-practice testing scores | |
| --- | --- | --- | --- | --- |
|  | M | SD | M | SD |
| CON | 52.3 | 13.0 | 56.3 | 11.1 |
| PRA | 47.2 | 12.7 | 59.9 | 8.8 |
| AUG | 53.1 | 9.9 | 69.3 | 12.7 |

314

315    *Notes*: Scores are points out of 100 and expressed as mean (*M*) and (*SD*). CON: control

316    group; PRA: practice group; AUG: augmented feedback group.

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