

1 Running Head: TRAINING VISUAL EXPLORATORY ACTIVITY

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3 **Using an Imagery Intervention to Train Visual Exploratory Activity in Elite Academy**
4 **Football Players**

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Abstract

23 Football players adapt their movements to opportunities within the surrounding environment by
24 engaging in Visual Exploratory Activity (VEA) to pick-up information. This study adds to the
25 extant literature by using a six-week PETTLEP imagery intervention to train VEA and improve
26 performance with the ball. A single-case, multiple-baseline across participants' design was
27 conducted with five elite academy football players. Results indicated that a PETTLEP imagery
28 intervention improved VEA, particularly in center midfielders. Additionally, indications of
29 improvements in performance with the ball were present within some participants. Future
30 researchers could examine the processes underpinning VEA to enhance applied interventions for
31 this skill.

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33 Key words: Visual exploratory activity, PETTLEP imagery, affordances, decision-making

57 sports, Jordet (2005) defined exploratory activity as “A body and/or head movement in which the
58 player’s face is actively and temporarily directed away from the ball, seemingly with the
59 intention of looking for teammates, opponents or other environmental objects or events, relevant
60 to the carrying out of a subsequent action with the ball” (p.143). The importance of such
61 behavior is thought to support skilled performance as analysis of elite football players indicates
62 that a higher frequency of VEA before receiving the ball is reflective of a higher forward passing
63 accuracy (Jordet, Bloomfield, & Heijmerikx, 2013).

64 Engagement in exploratory actions is thought to be critical for the acquisition of
65 perceptual-motor control (Adolph, Eppler, Marin, Weise, & Clearfield, 2000) as this supports the
66 attunement of actions to changing properties of the environment (Reed, 1996). For example, in a
67 recent climbing study, Seifert and colleagues revealed that behavioral exploration during practice
68 led to increased climbing fluency in a transfer test (Seifert, Boulanger, Orth, & Davids, 2015).
69 Such evidence highlights that exploratory or variable actions can play a performatory role during
70 the control of action (Stoffregen & Mantel, 2015). Specifically, prospective or anticipatory
71 control has been conceptualized as “exploration from a distance” (Adolph et al., 2000, p.447),
72 whereby ongoing movements are adapted to changes in the environment to generate information
73 or possibilities for the control of subsequent actions. In the context of sport, initial findings have
74 highlighted the importance of anticipatory control where the availability of advance visual
75 information is used to control ongoing actions, such as a goalkeeper’s movements when facing a
76 penalty kick (e.g., Dicks, Button, & Davids, 2010).

77 Given that anticipatory control is critical to performance in sport, a number of studies
78 have investigated whether this facet of skilled performance can be enhanced through training, in
79 particular, via video-based simulations (for a review, see Dicks, van der Kamp, Withagen &

80 Koedijker, 2015). Dicks and colleagues highlighted that although a large number of video
81 training studies have been conducted (e.g., Williams, Ward & Chapman, 2003), the vast majority
82 have not included transfer tests to examine whether changes in performance on video-based tasks
83 of anticipation and decision-making lead to commensurate improvements during on-field
84 improvements. An example of previous research that has examined on-field performance is the
85 study conducted by Jordet (2005), who investigated whether an imagery intervention combined
86 with observation of video footage could improve the decision-making of elite football players.
87 Following the intervention, the players were found to increase the amount of VEA, although
88 there were no improvements in decision-making. The absence of performance improvements
89 exhibited were explained by a ‘ceiling effect’ as the participants were playing at an elite,
90 international level. Despite this finding, it has been proposed that an imagery intervention, as
91 used by Jordet (2005), may support the development of perceptual skill (e.g., Smeeton, Hibbert,
92 Stevenson, Cumming, & Williams, 2013).

93 An imagery intervention that has received much attention in the sport psychology
94 literature is the PETTLEP model (for a review, see Wakefield, Smith, Moran, & Holmes, 2013).
95 The PETTLEP model (Holmes & Collins, 2001) emphasizes that imagery interventions should
96 be individualized and aim to simulate a performer’s execution situations, with emphasis on
97 experiences associated with movements and their associated emotional consequences. The seven
98 components of the PETTLEP model (Physical, Environment, Task, Timing, Learning, Emotion
99 and Perspective) can be used individually or in combination to increase the effectiveness of an
100 imagery intervention (Holmes & Collins, 2001). Interventions using adult participants have
101 supported the use of PETTLEP imagery in improving performance of motor skills (e.g., Smith,
102 Wright, Allsopp, & Westhead, 2007; Smith, Wright, & Cantwell, 2008). A study of junior

126 Five male participants were recruited from an under 18 elite (professional) UK academy
127 football team. All participants were aged 16 and 17 and provided informed written consent
128 before taking part in the study. The five participants were selected based on their position in the
129 team's formation; only midfielders and forwards were recruited after a discussion with the
130 team's coach regarding position-specific responsibilities. This was attributed to the hypothesis
131 that to support successful action, midfielders and forwards need to engage in VEA prior to
132 receiving the ball (Jordet et al., 2013). Participants 1 and 3 played as central midfielders,
133 Participants 2 and 4 played as wide midfielders and Participant 5 played as a center forward. The
134 study was approved by the lead author's University's ethics committee.

135 Experimental Design

136 A single-case, staggered multiple-baseline across-participants design was used to explore
137 intervention effects for each participant. The multiple-baseline design remains the most effective
138 design for exploring intervention effects in sport psychology research (see Barker, Mellalieu,
139 McCarthy, Jones, & Moran, 2013). In this design, the introduction of the intervention typically
140 takes place when a stable baseline of the dependent variable is achieved, or performance moves
141 in a direction opposite to that expected following treatment (Hrycaiko & Martin, 1996). Each
142 participant acts as their own control, thus allowing for comparison at a within-subject level
143 between baseline and post-intervention phases (Gage & Lewis, 2013).

144 The order of participants taking part in the intervention was determined by the most
145 stable baseline measures across the first five matches (equivalent to four weeks; Carr, 2005). The
146 present study lasted 21 weeks and the intervention was introduced to Participant 1 in week 5,
147 which is in line with previous research (e.g., Wakefield & Smith, 2011). The intervention lasted
148 for six weeks for each participant, except for Participant 4 who completed a seven-week

149 intervention as a minor injury prevented him from training for one week. Participants completed
150 one supervised imagery session per week and were encouraged to complete two individual
151 sessions per week (recorded using an imagery diary; Jordet, 2005) as using PETTLEP imagery
152 for three times a week (Wakefield & Smith, 2009) for six weeks (Finn, Grills, & Bell, 2009) has
153 been suggested as an effective frequency of intervention.

154 Procedure

155 *Data Collection.* Recordings of 19 matches in the team's season were analyzed to collect
156 performance data. Ten randomly selected situations – less than ten if a participant was used as a
157 substitute – were collected from each match. A situation was collected if the participant was in
158 control of the ball and visible on camera for at least 5 seconds before receiving the ball.

159 *Intervention.* The imagery intervention consisted of the participants imagining themselves
160 in a match situation and engaging in VEA before receiving the ball. The principal investigator
161 and the football club's academy sport psychologist in training led the intervention. Prior to
162 starting the intervention, the coaching staff were consulted to outline each participant's position
163 in the team's formation and expectations of the position in the team. Specifically, the coaching
164 staff provided information regarding the team's playing philosophy to ensure that the
165 intervention was individualized and underpinned the team's tactics and style of play.

166 Participants completed the MIQ-R (Hall & Martin, 1997) as part of the first intervention
167 session to provide baseline imagery ability scores. The following intervention sessions focused
168 on upcoming match situations using personalized scripts that were developed with the feedback
169 of the coaching staff. Participants also had the opportunity to watch video sequences of their
170 VEA in a recent match situation before engaging in imagery. The imagery script instructed
171 participants to engage in VEA as if they were searching for information away from the ball but

172 the participant decided the pattern of play, for example: “As the ball is travelling towards you,
173 imagine checking for team mates in advanced positions. Imagine controlling the ball. You have
174 the ball, now I want you to imagine what you will do with the ball”. The participants were
175 instructed to image three match scenarios and actions in each session. The imagery scripts are
176 available upon request from the first author.

177 Components of the PETTLEP model (Holmes & Collins, 2001) were used in the
178 development of the script. The Physical and Perspective components of the PETTLEP model
179 were manipulated by instructing participants to ‘step inside’ the video with their eyes closed as if
180 they were preparing to receive the ball (Smeeton et al., 2013). To use elements of the
181 Environment component, participants were told to feel the pitch beneath them and imagine the
182 weather of the upcoming match. Task and Timing components were manipulated by allowing the
183 participant to ‘play’ the ball and this encouraged the participants to think about future action
184 opportunities (Jordet, 2005; Smeeton et al., 2013). Discussions with each participant after
185 imagery revealed the outcome of the imagined scenario (e.g. team scoring a goal), which
186 engages the Emotion component (Smith et al., 2007).

187 During the intervention, participants were asked to complete an imagery diary to record
188 the number of individual imagery sessions performed (Wright & Smith, 2009) and to note down
189 any difficulties that they experienced while performing imagery (Wakefield & Smith, 2011).
190 Participants were encouraged to use their imagery script once individually and to observe one
191 televised football match every week. The purpose of watching a game was for the players to
192 observe the VEA of an elite player in their position and to make notes of their observations in
193 their imagery diary. Throughout the six weeks, Participants 1 and 5 completed seven individual
194 sessions, Participant 2 completed five, Participant 3 completed six, Participant 4 completed four.

195 Once the participants had gained a clear understanding of the scripts, instructions shifted
196 to the use of action lexicon such as ‘search’ and ‘scan’ (Jordet, 2005). Furthermore, videos were
197 removed from the sessions. The rationale behind this shift was to ensure that script was easier to
198 practice following the completion of the intervention and such imagery applied the Learning
199 element of the PETTLEP model (Holmes & Collins, 2001).

200 Dependent Measures

201 *Visual Exploratory Activity.* The measure of VEA was based on Jordet’s (2005)
202 definition of exploratory search. VEA was calculated by recording the number of explorations in
203 a situation and dividing it by the number of seconds of that situation. The final five seconds
204 before receiving the ball was defined as the online scanning period and any footage visible of the
205 participant 10-5 seconds before receiving the ball was defined as the extended scanning period.

206 *Action Completion Rate.* An action was considered successful if it resulted in continued
207 possession of the ball for the team. Action completion rate was calculated by dividing the
208 number of successful actions by the number of situations selected for analysis in a match.

209 *Direction of Actions.* The number of forward actions and actions that were performed in a
210 different direction to the direction of receiving the ball were recorded in each match. Actions
211 were analyzed using Kinovea and were recorded as ‘performed in a different direction’ if the
212 angle between the pass to the participant and the participant’s action was greater than 90°.

213 *Decision-Making.* Using action completion rate in isolation would not differentiate
214 between a successful *risky* forward pass and a successful short backwards pass. Therefore,
215 situations were evaluated by two coaches (with UEFA B qualifications) on a scale of 1-7 and
216 were typically scored as follows; 1-3 if the player in possession unnecessarily lost the ball, 4
217 reflected intermediate performance and 5-7 for penetrating or efficient actions (Jordet, 2005).

218 *Imagery Ability.* Following previous PETTLEP studies (Smith et al., 2008; Wakefield &
219 Smith, 2011), imagery ability was scored using a 7-point Likert scale in response to the MIQ-R
220 (Hall & Martin, 1997). The MIQ-R is an eight-item questionnaire that assesses one's ability to
221 perform visual and kinesthetic imagery. Participants were asked to rate the ease or difficulty of
222 imaging the movement ranging from 1 (very hard to see/feel) to 7 (very easy to see/feel).

223 *Social Validation.* Participants were interviewed every two weeks to ascertain their
224 thoughts on the progress of the intervention (see Page & Thelwell, 2013). Participants and the
225 coach engaged in post-intervention interviews to explore the effectiveness of the intervention and
226 its effects (Barker et al., 2013; Page & Thelwell, 2013). The interviews allowed open-extended
227 answers to be given based on the outcomes and experiences of the intervention.

228 Procedural Reliability

229 To ensure that each participant was treated equally, post-intervention scores were not
230 viewed until all participants had completed the entire data program. Further, the pre-determined
231 and structured nature of the intervention protocol ensured consistency of delivery across all
232 participants (Barker et al., 2013).

233 Data Analysis

234 Ten match situations were selected at random and were analyzed from all situations
235 collected in each match. Kinovea was used to analyze situations and collect quantitative
236 performance data as this software program had the capacity to clip matches and a zoom tool to
237 analyze VEA. Decision-making was analyzed by two qualified coaches (UEFA B Licence) using
238 the 1-7 scale (Jordet, 2005). The final data was analyzed using visual graph inspection. Visual
239 graph analysis with comparison of mean values is recognized as an accepted alternative to
240 statistical techniques in SCD's, with six features of the graphic display that can be interpreted:

309 central position” as they “require 360° awareness”. The coach was very positive on the
310 performance impact that the intervention had, stating, “The quality and frequency of the scans
311 certainly improved”. The coach felt that the intervention and imagery scripts were suitable for
312 the purpose of the study and were manageable alongside the regular training of participants.

313 **DISCUSSION**

314 The purpose of the present study was to examine whether a combined PETTLEP imagery
315 and video training intervention can improve VEA and decision-making in elite academy level
316 football players. We aimed to examine the benefits of a perceptual training intervention beyond a
317 laboratory setting and whether the previous lack of improvement in performance can be
318 attributable to ceiling level performance (Jordet, 2005). Following previous research (Jordet,
319 2005), we hypothesized that the imagery intervention would produce an increase in VEA and
320 improve performance with the ball in match situations as a higher level of VEA has been shown
321 to be reflective of improved performance (Jordet et al., 2013). The imagery intervention of
322 Jordet’s (2005) study demonstrated improvements in VEA of elite football players with
323 international caps, but recorded no improvements of performance with the ball. The participants
324 of the present study were academy level football players and thus, we expected, had scope for
325 improvement in performance with the ball. The present study lends partial support to our
326 hypothesis and is consistent with past research in that the use of an imagery intervention
327 enhanced VEA. However, there were no consistent improvements in performance with the ball
328 across all participants (Jordet, 2005). The strongest indications of improvements in VEA were
329 displayed in center midfielders (Participants 1 and 3) and supported by the view of the team’s
330 coach that center midfielders require “360° awareness” (see Figure 1). Although there were
331 smaller indications of improvements in VEA for wide midfielders (Participants 2 and 4), and the

332 team's center forward (Participant 5), decision-making of all participants improved when
333 comparing post-intervention to baseline (see Figure 3). Action completion rate data was variable,
334 although substantial improvements are indicated for Participant 1 (see Figure 2), and there were
335 no intervention effects on action completion rates for all participants when playing the ball
336 forward or in a different direction to which the ball was received.

337 Our results indicate that exploratory behavior appears to play a critical role in perception-
338 action across extended and online time-scales. Without anticipatory control, an individual's
339 action would be reduced to mere reaction, which would not suffice in fast-paced sport
340 environments (Fajen et al., 2009). In our present study, the improvements reported in online
341 VEA appear to play an important role in decision-making performance. Specifically, VEA in the
342 final five seconds before receiving the ball appeared to enable participants to exploit information
343 that supported subsequent actions with the ball. Such suggestion is in line with previous findings,
344 which indicate that online adjustments ensure that actions can be performed within a performer's
345 action capabilities (Dicks, Davids et al., 2010; Orth et al., 2014).

346 Increased VEA may lead to the search for *more* information, which would present further
347 potential opportunities for action (affordances). Perception of opportunities for action will be
348 grounded in a football player's physical and technical capabilities (Fajen et al., 2009). Thus, a
349 football player can be exposed to more information in the environment, in the sense that they are
350 relying on an informational variable, but this extra information may not be calibrated to their
351 action capabilities (Dicks et al., 2015; Fajen et al., 2009). It is possible that for complex
352 perceptual-motor skills that take place within dynamic sport situations, this period of
353 (re)calibration may require a long duration of practice and hence why the more stable changes of
354 performance with the ball are observed for participants with the longer post-intervention phases.

355 Future work may therefore benefit from examining performance improvements over a longer
356 post-intervention period. Although post-intervention improvements were reported for decision-
357 making (see Figure 3), participant performances were typically recorded as being at an
358 intermediate level (4). Strong indications of an improvement in performance with the ball were
359 noticeable in isolated cases, however lack of widespread improvements across participants can
360 potentially be attributed to the design of the PETTLEP imagery, which emphasized simulations
361 of VEA but not necessarily decision-making (see also, Jordet, 2005). Overall, the video and
362 imagery intervention may have led to a positive change in online VEA, however this same
363 intervention did not transfer to the control of opportunities for action for all participants.

364 Although the imagery intervention produced post-intervention improvements in imagery
365 ability for all participants (see Table 1), there were only a minority of participants who displayed
366 clear improvements in performance with the ball. This finding suggests that the combined video
367 and imagery intervention may have led to improvements in vision for perception but had no
368 effect on vision for perception-action (van der Kamp et al., 2008; Dicks et al., 2015). It has been
369 suggested that PETTLEP imagery scripts may develop perceptual-motor skill associated with
370 ventral system (vision for perception) processes (Holmes & Collins, 2001; Wakefield et al.,
371 2013), which act on a longer timescale than the online control of actions (Madary, 2011; van der
372 Kamp et al., 2008). In contrast, dorsal system (vision for action) processes play a fundamental
373 role in anticipation (Madary, 2011) and are underpinned by information exploited during
374 movement control (van der Kamp et al., 2008). That is, it is plausible that there were no
375 substantial improvements with the ball observed in the present study as the PETTLEP
376 intervention may only primarily support processes associated with vision for perception (ventral
377 system) and not vision for action (dorsal system). Complementary to views highlighted

378 elsewhere (e.g., Wakefield et al., 2013) future researchers would benefit from the exploration of
379 the time-scales of perceptual-motor control that are best supported by imagery interventions.

380 The design of the present study enabled social validation to be collected during the
381 intervention through fortnightly semi-structured interviews (Page & Thelwell, 2013). Participant
382 4 represents an example of the usefulness of participant interviews during the intervention phase,
383 as this allowed the adaptation of his intervention to seven weeks due to injury. Researchers using
384 single-case designs (SCD) should implement regular social validation to further individualize the
385 intervention for respective participants. Consistent with recent SCD research (e.g., Turner &
386 Barker, 2013), a post-intervention interview was administered with the team's coach. The
387 coach's positive comments on the development of the participants reinforce the effectiveness of
388 the intervention. The strongest suggestions of an intervention effect are reflected in Participant 1,
389 which was supported by the coach's interview. Reporting the views of a coach adds to the VEA
390 literature that has previously only reported the views of participants (Jordet, 2005).

391 Social validation data indicated that the coach recognized that the frequency and *quality*
392 of scans (VEA) had improved. Improvements in perceptual-motor skill are likely to reflect
393 enhanced attunement of exploratory behaviors to task demands (Reed, 1996). Thus, ongoing
394 VEA may become unnecessary if players are attuned to information that will support subsequent
395 perception-action (Dicks et al., 2015). Given previous findings (Jordet et al., 2013), such
396 interpretation appears most appropriate for wide positions as there were minimal post-
397 intervention effects on VEA in these players (Participants 2 and 4). Nevertheless, both wide
398 midfielders (right midfielder and left midfielder) improved decision-making when comparing
399 post-intervention performance to baseline. This suggests that the imagery intervention improved
400 the quality of VEA (albeit at an intermediate level) due to the wide midfielders learning where

401 and when to scan. Thus, analogous to findings of differences in the physiological demands of
402 respective football player positions (e.g., Gonçalves, Figueira, Maçãs, & Sampaio, 2014), our
403 study indicates that perceptual-motor skill demands appear to vary between playing positions.
404 Future researchers should consider further examination of how VEA is adapted relative to
405 changes in player abilities (e.g., Dicks, Davids et al., 2010) and player position. Moreover,
406 further researchers should accommodate individual differences in perceptual learning
407 interventions (Dicks et al., 2015). In this regard, the individualized nature of the PETTLEP
408 intervention (Wakefield et al., 2013), means that such position- and player-specific requirements
409 can be catered for during training. Despite the significant scope available for future researchers,
410 the current study provides practical recommendations for coaches within similar settings,
411 namely; (i) the need for an awareness of the importance of VEA in the development of decision
412 making and specific performance outcomes, particularly in players within certain playing
413 positions, (ii) the importance of integrating perceptual skill training interventions alongside those
414 of a technical and physical nature to develop VEA behaviors, (iii) and the potential efficacy of
415 imagery and video training as a supplement to physical practice to facilitate such development.

416 The results from our study lend support to previous research (Jordet, 2005) and show that
417 a PETTLEP based imagery intervention can produce improvements in VEA of elite academy
418 level football players. Future researchers should seek to understand the time-scales of perceptual-
419 motor control that are best facilitated by imagery interventions. Moreover, future researchers
420 could examine how differences in player position and abilities influence VEA. Finally, the
421 present study was one of the first to use regular social validation with young athletes in a SCD
422 (Page & Thelwell, 2013) and therefore researchers may consider the use of ongoing social
423 validation to tailor the intervention to the participant's needs and to explore intervention efficacy.

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Figure Captions

Figure 1: Pre- and post-intervention VEA in the extended and online scanning periods^a.

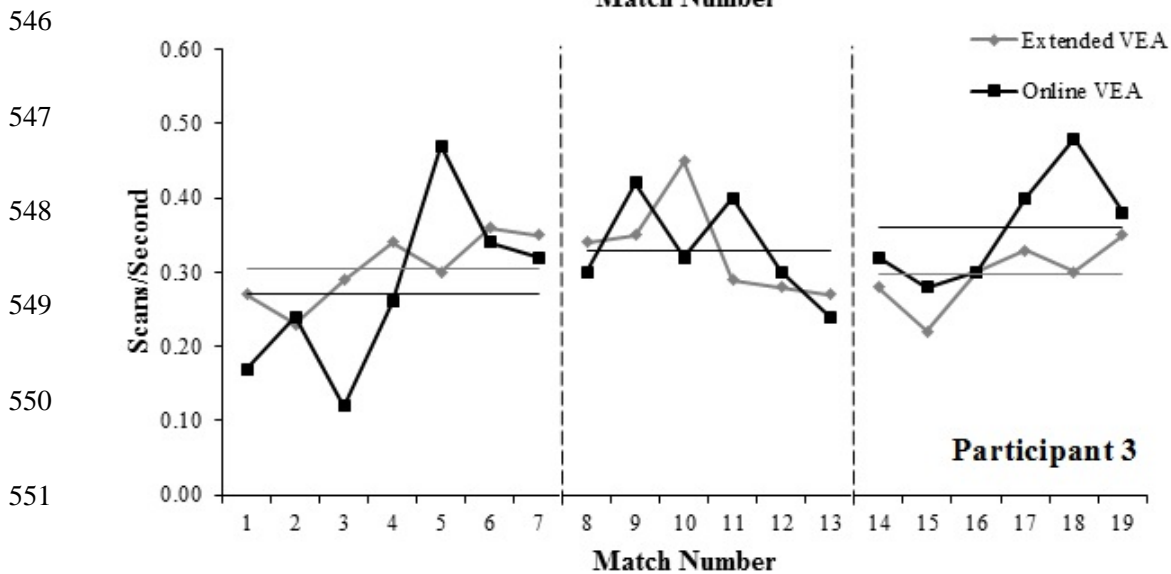
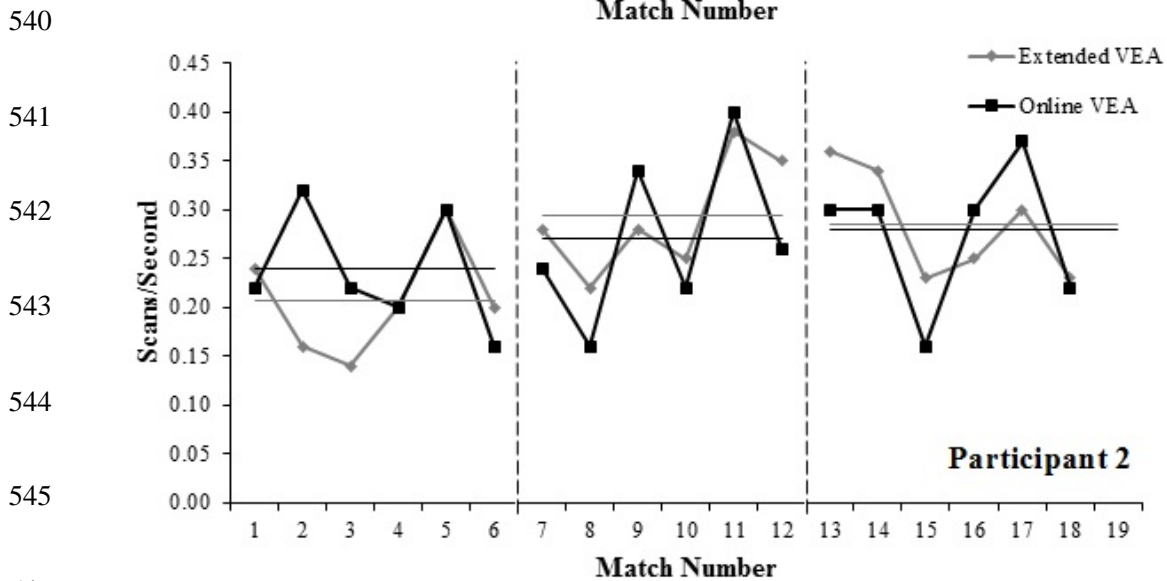
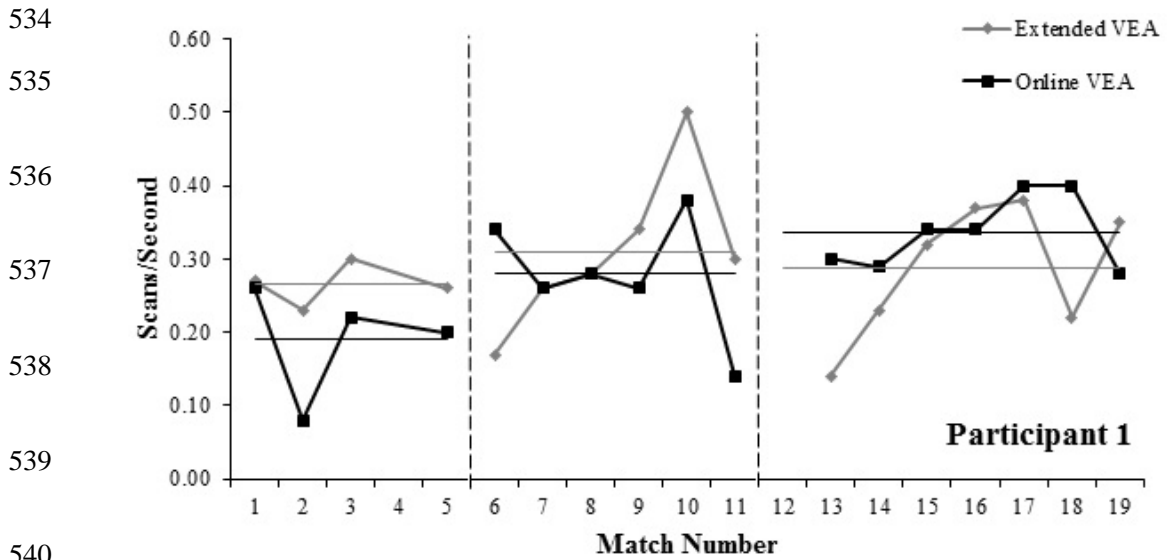
^a Missing data points are due to injury or non-selection. Participant 4 sustained a minor injury during the intervention period and the intervention was prolonged to seven weeks for this participant.

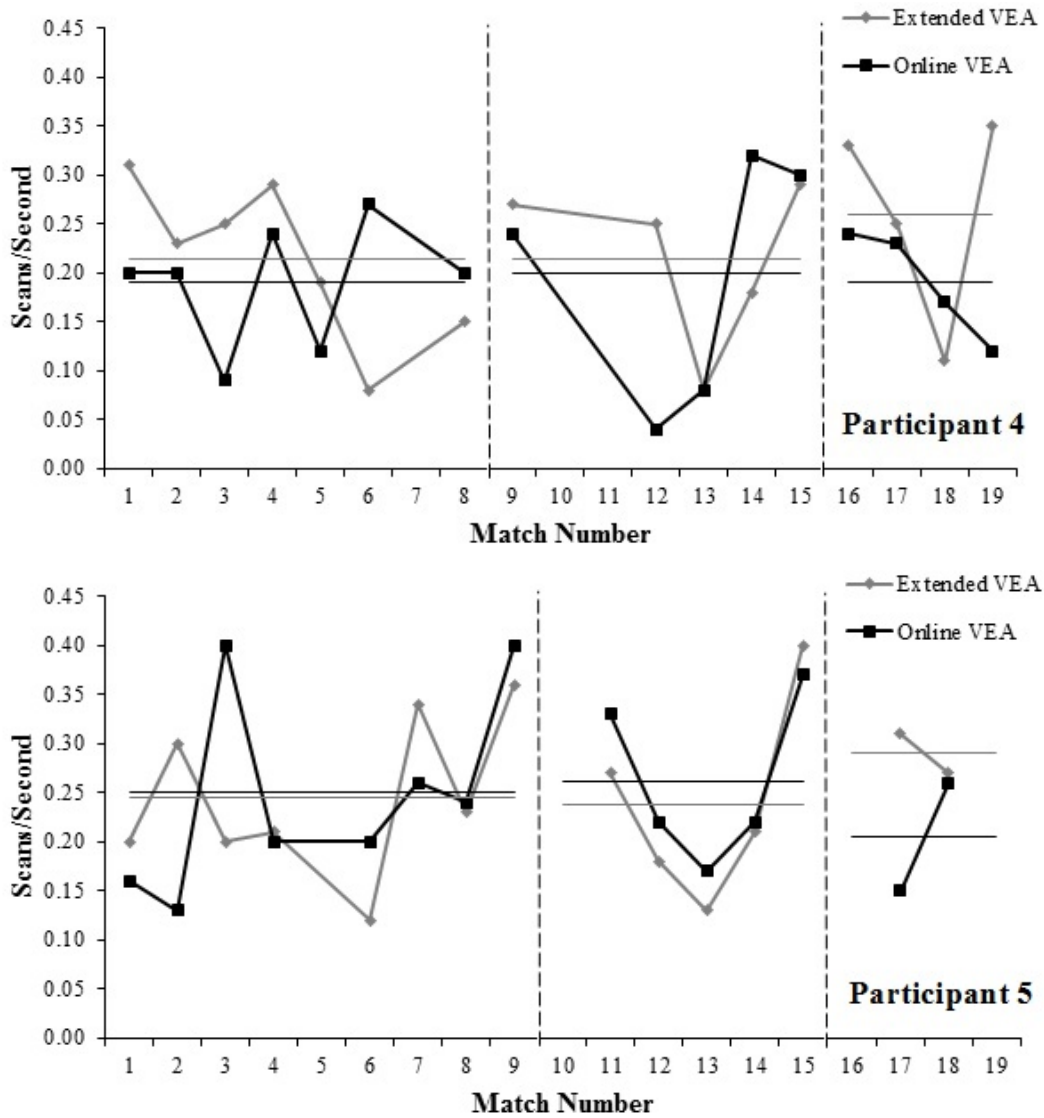
Figure 2: Pre- and post-intervention action completion rates.

Figure 3: Pre- and post-intervention decision-making scores.

Table 1: Baseline and post-intervention imagery ability scores.

533 **Figures**





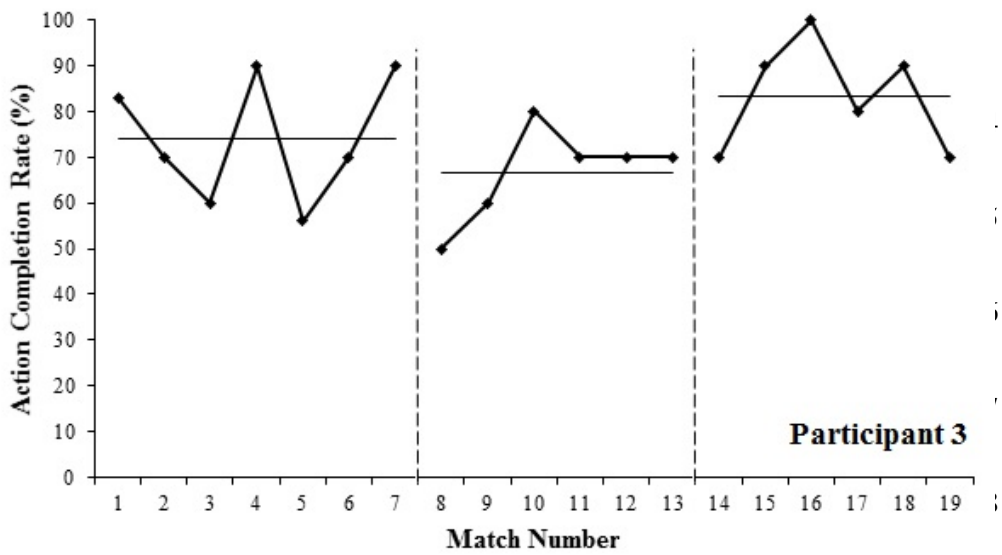
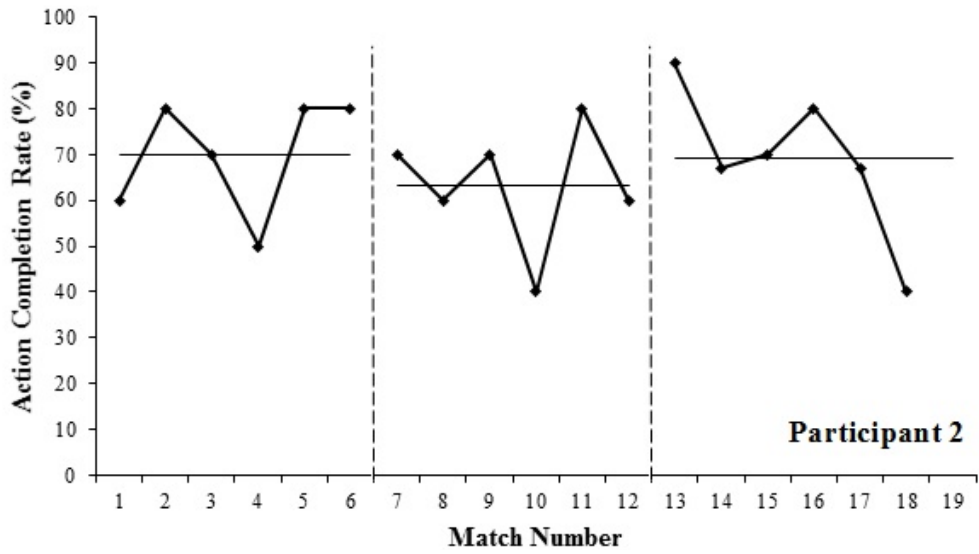
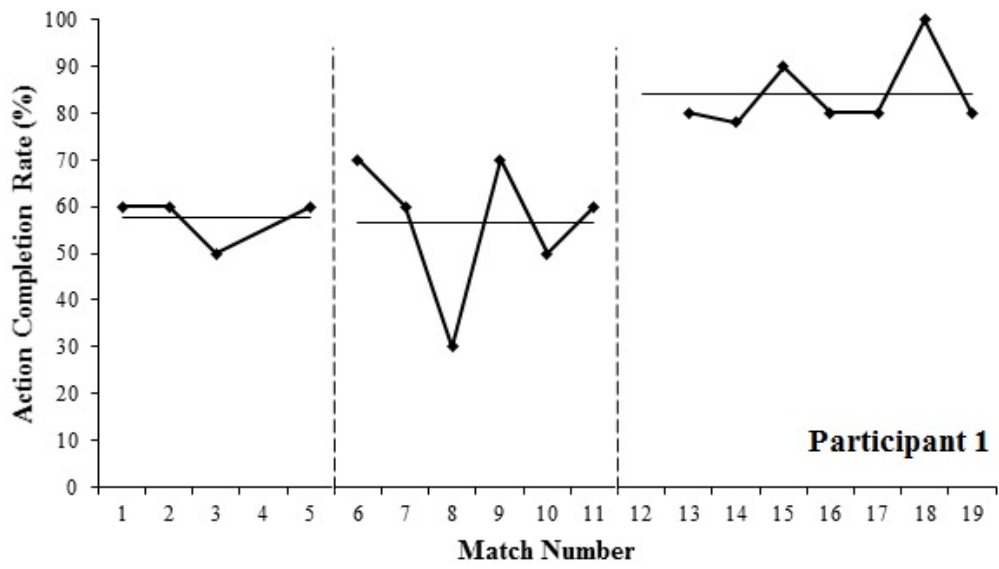
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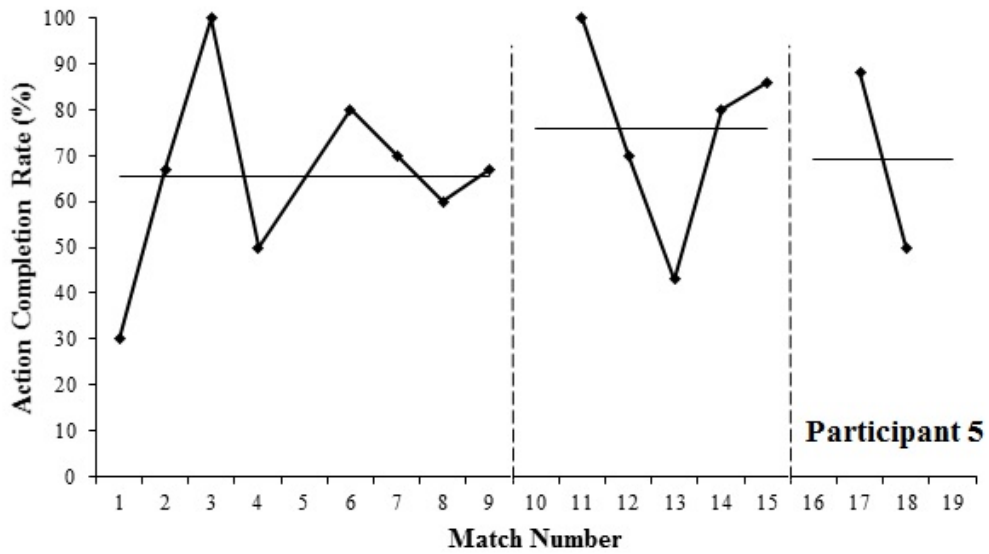
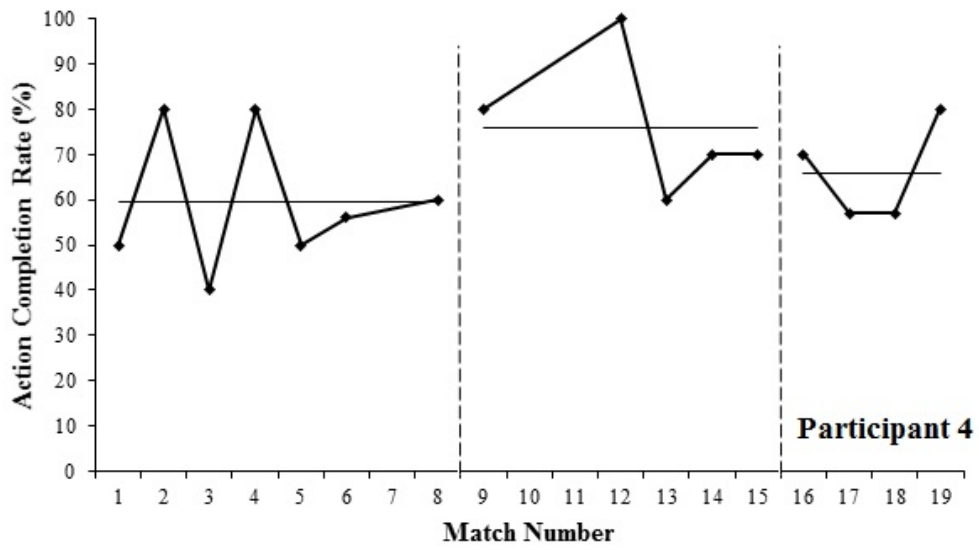
565 **Figure 1:** Pre- and post-intervention VEA in the extended and online scanning periods^a.

566 ^a Missing data points are due to injury or non-selection. Participant 4 sustained a minor injury
 567 during the intervention period and the intervention was prolonged to seven weeks for this
 568 participant.

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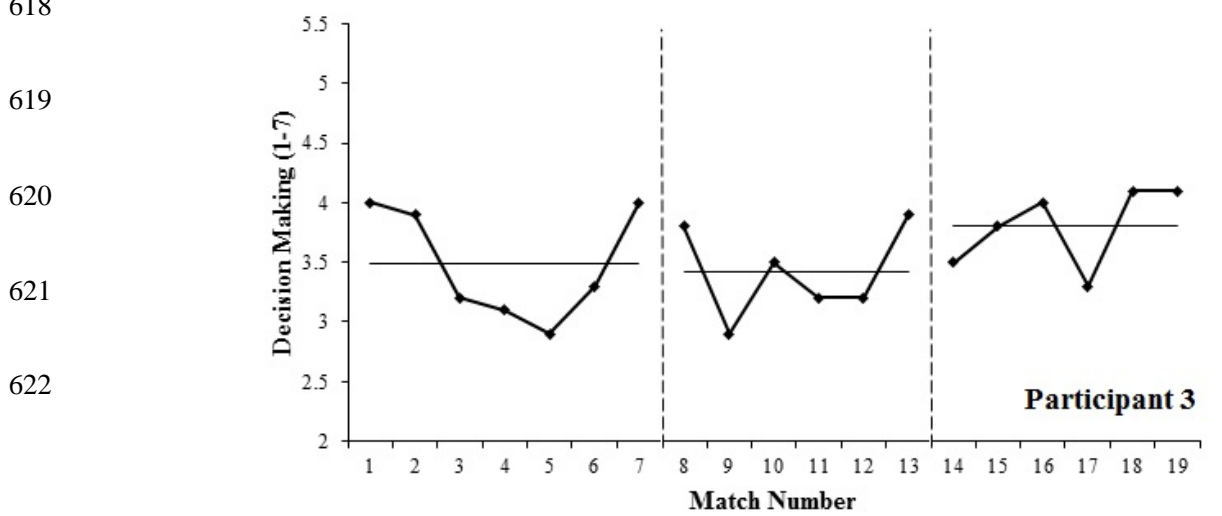
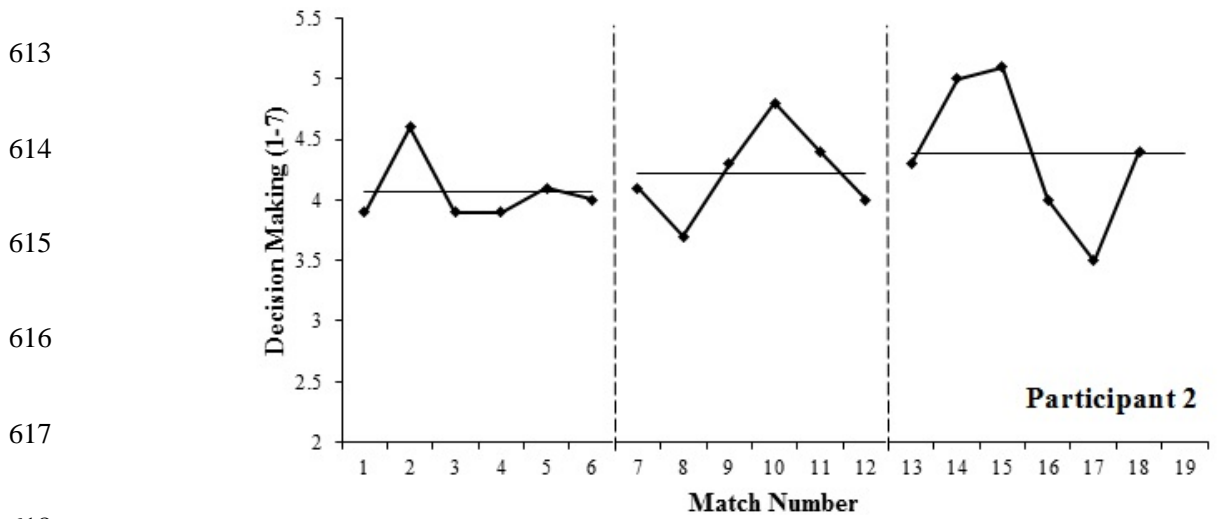
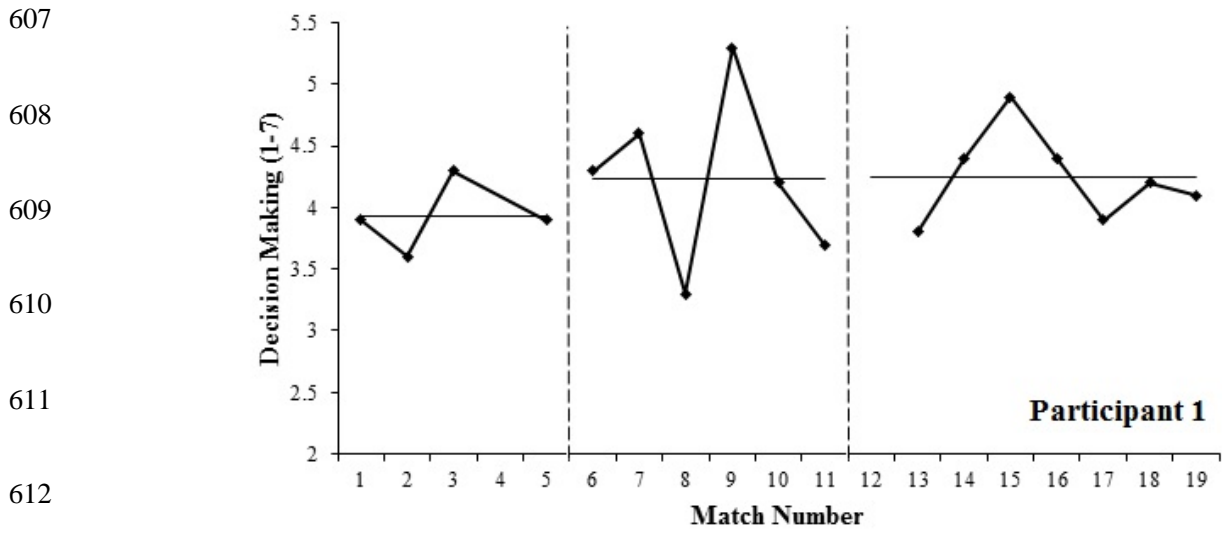
602 **Figure 2:** Pre- and post-intervention action completion rates.

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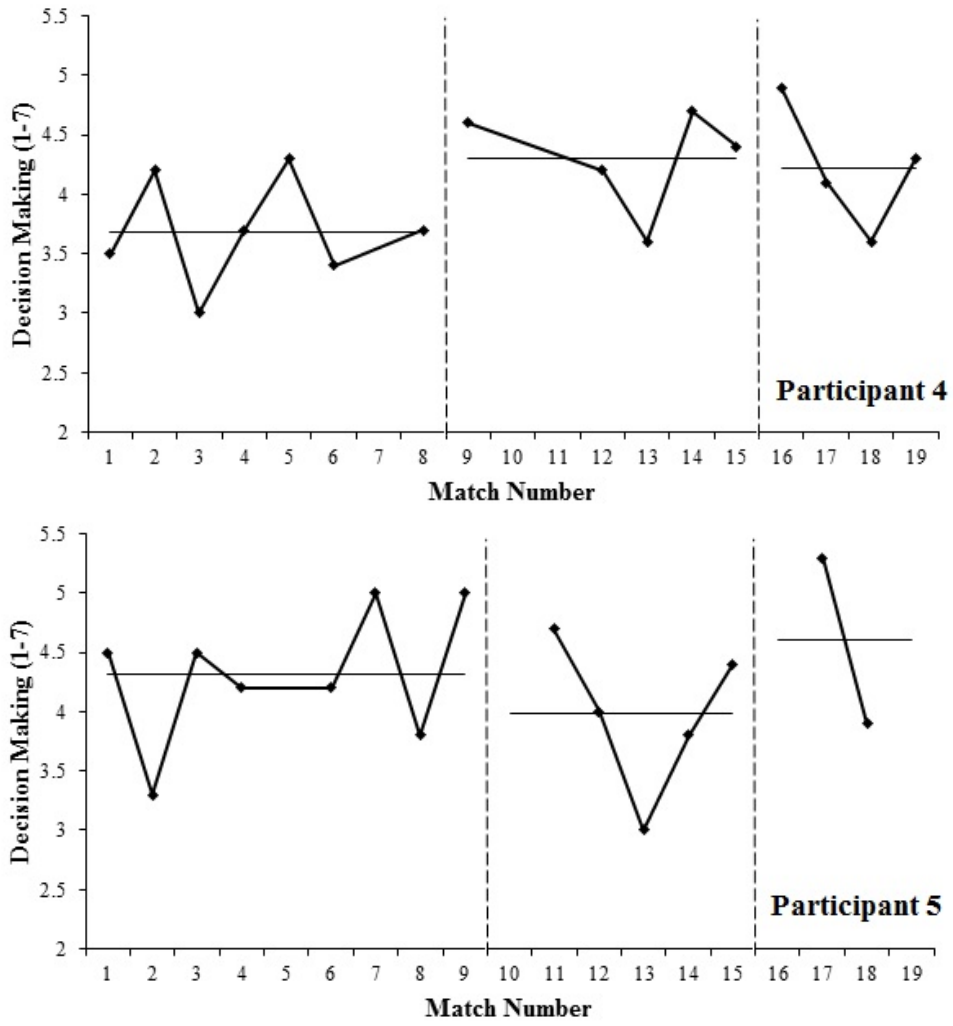


Figure 3: Pre- and post-intervention decision-making scores.

641 **Table 1:** Baseline and post-intervention imagery ability scores.

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	Baseline				Post-Intervention			
	Visual		Kinesthetic		Visual		Kinesthetic	
Participant	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
1	6.00	0.00	3.00	0.82	6.25	0.50	5.50	0.58
2	4.75	0.50	5.25	0.50	5.25	0.96	5.25	0.50
3	2.00	0.82	2.75	1.26	5.50	0.58	5.50	0.58
4	4.75	0.50	3.00	0.82	5.75	0.50	5.75	0.50
5	6.00	0.00	4.25	0.96	6.75	0.50	6.50	0.58