Imagery Intervention to Increase Flow State and Performance in Competition

Abstract

The purpose of this study was to examine the effectiveness of an imagery intervention for enhancing the experience of flow state and performance in junior athletes. On the basis of previous results, a tailored imagery script was developed to target critical flow dimensions, namely challenge-skills balance, clear goals, concentration on the task, and sense of control. It was hypothesised that the use of cognitive and motivational imagery would increase specific flow dimensions, which, in turn, would enhance flow state and competition performance. Participants in a single-case, multiple baseline A-B design study were four nationally ranked athletes. Following a 6-week baseline phase monitoring flow state and performance and a 6-week intervention phase, three participants showed a sustained increase in flow experiences, and all four participants improved their service performance, groundstroke performance, and ranking-list position.

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Experiences and sport performance are closely intertwined and optimal experience is often related to superior performance (Jackson & Csikszentmihalyi, 1999). Athletes competing at their best have characterised their ideal performance state as being totally absorbed in and focused on the task, feeling confident and in control, while their body works effortlessly and automatically (Jackson, 1995; Jackson & Csikszentmihalyi, 1999). Optimal experiences in sport have been conceptualised as flow state (Kimiecik & Stein, 1992). The aim of this study was to evaluate the efficacy of a tailored imagery intervention to increase flow state and performance in competition.

Nine dimensions have been proposed to reflect flow experiences in sport, namely challenge-skills balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, time transformation, and autotelic experience (Jackson, 1995; Jackson & Eklund, 2002). Nakamura and Csikszentmihalyi (2002) reviewed the functions of the flow dimensions, proposing a distinction between dimensions that are crucial to get into flow, labelled flow conditions, and dimensions that signify the phenomenological experience during optimal states, labelled flow characteristics. Hence, challenge-skills balance, clear goals, and unambiguous feedback indicate proximal conditions conducive to flow, whereas the remaining dimensions reflect flow characteristics.

In a large-scale study with a Japanese sample involved in various physical activities, Kawabata and Mallett (2011) found some initial evidence to support the hypothesis that these dimensions indeed serve different functions of flow state. In sport, a number of research studies examined the contribution of flow dimensions to flow in national and international athletes (Jackson, Thomas, Marsh, & Smethurst, 2001), Masters athletes (Jackson, Kimiecik, Ford, & Marsh, 1998), and junior athletes (Koehn, Morris, & Watt, in press). Canonical correlation analyses employed across the three studies showed similar findings with strongest loadings for challenge-skills balance, sense of control, concentration on the task at hand, and clear goals, and weakest loadings for loss of self-consciousness and time transformation (Jackson et al., 1998; Jackson et al., 2001; Koehn et al., in press). The findings partly supported contentions by Nakamura and Csikszentmihalyi (2002) that challenge-skills balance and clear goals are central for the flow experience across sports. The theoretical distinction between antecedents and concomitants of flow in conjunction with previous research findings provides vital information for the development of interventions and the targeting of main flow dimensions to enhance flow state.

A series of intervention studies that aimed to increase both flow state and performance employed hypnosis as the treatment of choice (Lindsay, Maynard, & Thomas, 2005; Pates, Cummings, & Maynard, 2002; Pates, Oliver, & Maynard, 2001). Using a similar intervention procedure, participants reflected on their experiences during best performances. As part of a multi-stage hypnosis treatment, athletes' memory of a positive experience was conditioned to a trigger, such as a golf club (Pates et al., 2001) or a bicycle handlebar (Lindsay et al., 2005). The trigger was designed to set off best-performance experiences and, in turn, enhance flow and performance. Although Pates and colleagues (2001, 2002) generally found positive intervention effects on flow, this approach is methodologically problematic, because none of the studies evaluated the quality of participants' reports of best performance experiences as being identical with or akin to flow state. Therefore, the trigger could be attributed to a state that was substantially different from, or merely a resemblance of, flow. Future intervention studies need to carefully choose and measure dependent variables. Ideally, theory or research findings should inform researchers' decisions on the targeted outcome variables.

Pates, Karageorghis, Fryer, and Maynard (2003) investigated the effect of performance imagery and self-selected music on flow and performance in a training task with three college netball players between 12 and 19 years of age. Pates et al. (2003) outlined to the participants what is considered a flow state. Participants were instructed to recall images and experiences that reflected a personal flow experience, and rehearsed images of flow and performance. In addition, participants selected music that they thought would correspond to and facilitate their personal flow experience. In the post-intervention phase, participants performed another set of netball shots while listening to self-selected music. The results showed that two out of three participants increased in flow and all three enhanced their performance. Imagery appeared to be an effective alternative to hypnosis interventions, which require professional guidance to establish the trigger technique. It would be beneficial for athletes and coaches to consider using imagery over hypnosis techniques that can be readily incorporated into training and competition preparation.

Investigations into the relationship between imagery and flow in competition have rarely been carried out. Jackson et al. (2001) found moderate-to-strong positive correlations between imagery and dispositional flow. Within a sample of junior tennis players, Koehn et al. (in press) investigated the relationship between five imagery functions, namely cognitive specific (CS), cognitive general (CG), motivational specific (MS), motivational general-arousal (MG-A), and motivational general-mastery (MG-M), as measured by the Sport Imagery Questionnaire (SIQ; Hall, Mack, Paivio, & Hausenblas, 1998) and flow, as measured by the Dispositional Flow Scale-2 (DFS-2; Jackson & Eklund, 2002). Imagery types of CS ($r = .51$), CG ($r = .50$), and MG-M ($r = .48$) showed strongest correlations with flow on a global level, and with challenge-skill balance, clear goals, concentration on the task at hand, sense of control, and autotelic experience on a subscale level. The results indicated that imagery types have the potential to be applied as a main vehicle to increase flow.

The applied model of imagery (Martin, Moritz, & Hall, 1999) can be used as a guide for applied research interventions. The effectiveness of the use of the five imagery types is related to specific outcomes. For instance, using CS imagery is beneficial for skill-related outcomes, CG imagery for improving strategies and tactics, and MG-M imagery is most suitable for enhancing athletes' confidence (Hall, 2001). Imagery represents an interesting approach for applied sport psychologists and practitioners as a means to enhance optimal experience and improve performance in competitive athletes. Researchers have identified specific flow dimensions that reflect core aspects of flow in sports (Jackson et al., 1998; Jackson et al., 2001; Koehn et al., in press). Results showed that both cognitive and motivational imagery types were related to flow (Koehn et al., in press). Morris, Spittle, and Watt (2005) advocated that "imagery, which is specifically directed at the antecedents in a particular sport context, should enhance the experience of flow" (p. 327). The MG-M imagery type, in particular, should play an important part in an imagery intervention due to positive links to flow (Koehn et al., in press) and performance (Craft, Magyar, Becker, & Feltz, 2003). The purpose of this study was to examine the effectiveness of an imagery intervention for enhancing the experience of flow state and performance in junior athletes. In this study, a tailored imagery script was developed to target critical flow dimensions, namely challenge-skills balance, clear goals, concentration on the task, and sense of control (Koehn et al., in press). To increase the ecological validity of the study, the intervention was conducted in a competition setting. It was predicted that the use of specific imagery types, including CS, CG, and MG-M, would facilitate the experience of relevant flow dimensions, which, in turn, would increase flow state and competition performance.

Method

Participants

Four male tennis players between 13 and 15 years (*M* = 14) of age participated in this study. All participants had at least three years of tennis and two years of competition experience. The participants entered at least six tournaments per year, which were mainly ranking-list tournaments, including national championships. At the outset of the study, the participants' rankings ranged between 203 and 244 in the Australian National Junior Ranking list.

Design

A nonconcurrent, single-case A-B multiple-baseline design (Barlow & Herson, 1984; Kazdin, 1982) was employed to evaluate the efficacy of the imagery intervention. Hrycaiko and Martin (1996) advocate that using single-case designs facilitate the examination of intervention effects as it has the advantages of involving a small sample size, participants act as their own controls, and small changes in the outcome variables can be observed. The competition setting required that baseline and post-intervention phases were implemented individually for each participant at different points in time. The baseline phase varied in length, between four and six weeks, until each participant met a stability criterion, which was attained once the competition flow states were steady or revealed a trend that was opposite to the intended treatment effect (Hrycaiko & Martin, 1996; Kazdin, 1982). A concluding interview with the participants was incorporated as part of the social validation of the study. Previous studies have demonstrated that this type of design is beneficial for applied research to test intervention effects on variables, such as flow and performance, in real-world contexts (e.g., Lindsay et al., 2005).

Measures

Sport Imagery Ability Measure (SIAM; Watt, Morris, & Andersen, 2004). The SIAM assesses athletes' imagery ability in sport. Athletes are asked to imagine four generic sport scenes, consisting of the home venue, a successful competition, a slow start, and a training session, for 60 seconds each. Following imagery of each scene, athletes respond to a set of twelve questions reflecting several imagery dimensions (control, vividness, ease, speed of generation, and duration of the image) and imagery modalities (kinaesthetic, tactile, visual, auditory, olfactory, and gustatory senses associated with the image), and imagery of emotion. Responses are made on 100-mm analogue scales, anchored by opposing statements (e.g., *no image* and *perfectly clear image*). The scale ranges between 0 (left end of the scale) and 100 (right end of the scale), with the number of mm being equivalent to the number of points. The scale ranges between 0 (left end of the scale) and 100 (right end of scale). The total score for each subscale (i.e., the summed score of each item across the four scenes) varies between 0 and 400 points. Through the validation process, the SIAM revealed alpha values between .66 and .87 (Watt et al., 2004).

Flow State Scale-2 (FSS-2; Jackson & Eklund, 2002). The FSS-2 examines the intensity of flow state in one specific activity or event. The FSS-2 consists of 36 items including nine subscales and four items per subscale. The response format is a 5-point Likert scale anchored by 1 (*strongly disagree*) and 5 (*strongly agree*), with 3 as *neither agree nor disagree*. The subscales have shown acceptable internal consistency (Jackson & Eklund, 2002). For this study, the FSS-2 was modified by including two additional response scales to the original response scale to assess the flow intensity for each tennis competition set played. Accordingly, participants responded to each item twice or three times, depending on the number of sets played. The overall flow score per match was calculated as the mean from two or three response scales. Previous research found flow to be an ephemeral and volatile state

(Jackson, 1995). Measuring flow once for the entire competition would imply that flow was a constant, invariable state. In addition, reports on flow and subjective experience can be influenced by performance outcomes (Brewer, Van Raalte, Linder, & Van Raalte, 1991; Jackson et al., 2001). Therefore, players who won the final set may report a higher flow state than they experienced in the match, whereas the opposite may apply for players who lost the final set. The validity of the amended FSS-2 should not be compromised, because there were no changes in item or response format. This modification appears to be appropriate to gain accurate results on athletes' flow experiences during competition. The accuracy of flow measurements is important in connection with the use of a single-case design, because imprecise measurements can lead to misinterpretations of the intervention effect.

Competition performance. Competition performance was assessed by focusing on the number of winners hit by serves, and forehand and backhand groundstrokes. Winning shots were considered direct winners, as well as shots opponents were unable to reach or hit the ball in a controlled manner (e.g., hitting the ball on the frame). Competition matches were videotaped and subsequently analysed performance by transcribing the outcome of service and groundstroke shots on paper. Rallies that ended with either player hitting a volley at the net position were not included in the analysis, because net play was not part of the performance assessment. The service and groundstroke performance per match was calculated as a percentage score. The number of service winners (i.e., number of participants' services not returned in court) was divided by the overall number of service points played, times one hundred. Similarly, the number of groundstroke winners was divided by the overall number of rallies finished with a baseline shot, times one hundred.

In addition, participants' ranking-list position was assessed at the onset and conclusion of the study as an objective and ecologically-valid measure of overall performance. All competition matches were part of junior ranking-list tournaments, whose outcomes would affect their position in the rankings. The junior rankings are managed and published by the national governing body, Tennis Australia. At the time of the study, the Australian Junior Rankings list comprised 1,780 junior players between 10 and 18 years of age.

Adherence log. An adherence log was handed out to the participants to keep track of their experiences during the imagery sessions. The booklet provided space to comment on the imagery session during the intervention phase and to rate the vividness and clarity of the images on 11-point Likert scales (-5 = much weaker; +5 = much stronger) in comparison to their flow and performance imagery of the previous session.

Social validation interview. Following the post-intervention phase, social-validation interviews were conducted with each participant reflecting on experiences and performance during the study and potential changes, participants' commitment to using imagery, additional factors which may have affected their flow experience and performance, and whether participants noticed any changes in relation to their mental preparation for competition matches. Interview responses were transcribed verbatim and examined for statements related to these issues. Each interviews lasted for about 25 minutes.

Imagery Intervention

On the basis of correlational findings by Koehn et al. (in press), a standardised imagery script for the intervention was developed reflecting significant links between imagery use and flow dimensions (including challenge-skills balance, clear goals, concentration on the task at hand, and sense of control) in tennis competitions. Imagery was used as a vehicle to increase flow and performance with a focus on CS (combining flow aspects and technical performance), CG (combining flow aspects and tactical performance), and MG-M (combining flow aspects with being confident and a successful performance) imagery types. Two common performance situations of tennis service and groundstroke performances were integrated into the imagery script. An example of the cognitive-specific function linked with challenge-skills balance read

"You know you have the skills to hit the ball into the anticipated target area"; an example of cognitive-general imagery linked with clear goals read "The closer the ball comes the more focused you are, knowing that you will hit the ball into a specific target area"; an example of motivation general-mastery imagery linked with challenge-skills balance, and confidence read: "You are confident in your skills, even in tough match situations, knowing that you have the ability to meet the challenge and be successful." An example of the imagery script used is available from the authors.

Relaxation is an important precondition for inducing altered states that aim to change individuals' experiences and thought processes (Kirsch, 1994). Despite early findings that relaxation training can have potentially negative effects, for instance inducing anxiety (Heide & Borkovec, 1983), the sport psychology literature outlines relaxation and imagery as techniques that facilitate optimal experience and performance (Hardy, Jones, & Gould, 1996; Unestahl, 1983). Furthermore, relaxation is considered to have positive cognitive effects, for instance it allows athletes to clear their minds, particularly when relaxation methods are used prior to imagery techniques (Holmes & Collins, 2001). Previous intervention studies have frequently used relaxation and imagery in order to enhance the intervention effect on flow state and performance (Lindsay et al., 2005; Pates et al., 2002).

Each imagery session consisted of three parts, (a) relaxation techniques, (b) imagery of serves, and (c) imagery of groundstrokes. Participants were asked to make themselves comfortable in a relaxed position and start the session with relaxation and breathing techniques. They could choose whether they would feel more comfortable with their eyes open or closed at any time during the imagery session. Once a comfortable and relaxed state was obtained, participants slowly read through the instructions of the imagery script. The script addressed the sequence of three important parts of the service and groundstroke performance, namely pre-shot routine, vital aspects during performance, and performance outcomes. Following the detailed imagery, participants were instructed to image serves and groundstrokes in real time that took into account the actual speed and movements of their own and their opponent's performance. For example, the sequence and placement of groundstrokes should be similar to a typical baseline rally in a competition match that varies in length and intensity, although the final shot of the rally had to be a clean winner. Beyond five winning serves and five groundstroke winners per session, participants could imagine as many winning shots as they wished.

Procedure

The research was approved by the University's ethics committee. Access was requested to players in junior tennis squads run by Tennis Australia and private tennis clubs in Melbourne, Australia. Coaches passed on the information statement to the junior players. Players who wanted to participate in the study as volunteers returned the consent form signed by parents and themselves. The SIAM was administered to assess participants' imagery ability. Tournament directors provided support in accessing the various tournaments and consent was obtained from opponents to videotape participants' competition performance. Participants filled out the modified version of the FSS-2 within half an hour after the completion of each competition match. Participants reflected on each set separately, and the average score was taken for subsequent analysis. Baseline observations took place over a period of six weeks.

After the conclusion of the baseline phase, the imagery script was introduced to the participants and explanations on how to independently work with the script were provided. All participants received the same information and instructions orally and in written form. To enhance understanding of the intervention, a practice session was conducted in order to familiarise participants with all parts of the imagery script. In addition, participants were encouraged to ask questions and clarify any difficulties they experienced during the introductory session. Finally, participants received an adherence log to comment on their experience, such as image clarity, after each session.

The imagery intervention lasted for six weeks. Participants were asked to practice imagery three times per week, each session taking approximately 10 to 15 minutes. Instructions for the self-reliant use of the script included (a) to imagine vividly, as if being in this particular situation, (b) to imagine clearly and in detail what the situation and the performance are like, (c) to control the images (e.g., seeing oneself being successful), and (d) to use all the senses within the images, that is, images should include visual, auditory, kinaesthetic (e.g., within the muscles), tactile (e.g., touching racket and tennis ball), and olfactory (e.g., the aroma of new tennis balls) aspects of competition matches.

Following the intervention phase, participants were instructed to use imagery for 10 to 15 minutes as competition preparation. The post-intervention phase lasted up to six weeks. After completion of the post-intervention phase, a social validation interview was conducted with each of the participants to assess differences in their experiences between phases and the perceived effectiveness of the intervention on flow state and performance. Finally, participants were debriefed on their performance and flow experience and thanked them for their involvement in, and support of, the study.

Data Analyses

Visual inspection was used to assess graphs, applying the split-middle technique (Kazdin, 1982; White, 1971, 1974) to investigate changes in flow and performance scores across baseline and post-intervention phases. To determine intervention effects the celeration or trend line was assessed in each phase (Barlow & Hersen, 1984; Kazdin, 1982), as well as changes in mean scores across phases. Several assessment characteristics need to be present to draw accurate inferences from the interventions. The intervention effect is stronger when (a) the replication of the effect is evident across a number of participants, (b) the overlapping data points between baseline and post-intervention phase are minimal, and (c) an effect is detected near the onset of the post-intervention phase, followed by a sustained increase (Hrycaiko & Martin, 1996; Kazdin, 1982). In addition to the visual inspection of the celebration lines, Binominal tests were implemented to calculate statistical differences between baseline and post-intervention phases. For this analysis the celebration line is extended from the baseline into the post-intervention phase, showing the number of the data points that fall above the line following the intervention. Based on the Binominal test formulas provided by Callow, Hardy, and Hall (2001) (see Appendix B), we examined whether the intervention significantly increased participants' flow state, and service and groundstroke performance. Finally, a content analysis of the social validation interview was conducted to extract additional information on the effectiveness of the intervention and participants' experiences.

Result.

Imagery Ability

SIAM scores were typically above 200 points ($M_{Participant\ 1}$ = 337.67; $M_{Participant\ 2}$ = 247.17; $M_{Participant\ 3}$ = 288.08; $M_{Participant\ 4}$ = 220.50), except for the olfactory and gustatory subscales. These subscales appear to be less important, as both characteristics play a minor role in tennis competition. Participant 1 and 3 reported relatively high scores (> 300) on a number of subscales, such as vividness, control, duration of the image, visual and tactile sense, and emotion, whereas Participants 2 and 4 scored below the 300 on these subscales. Overall, these findings provided evidence that the participants' imagery ability was at least moderately high, allowing athletes to effectively use imagery.

Intervention Adherence

All participants confirmed in the adherence log that they frequently practiced imagery during the intervention period. Each participant completed a minimum of twelve imagery sessions over a period of six weeks. The time between sessions varied between two and four days, due to participants' tennis-related and school-related commitments. The imagery sessions were conducted between 4.00 pm and 8.30 pm. The mean session duration varied from 10 to 16 minutes. All participants reported a general increase in imagery vividness and clarity from beginning to end of the intervention phase.

Flow State in Competition

Figure 1 illustrates the development of flow state for all four participants. The vertical line signifies the break between baseline and post-intervention phases. Solid lines reflect the trend of flow state in each phase, the dotted celeration lines indicate the ongoing trend from the baseline phase, and dashed lines signify the mean values (M) of flow state in the baseline and post-intervention phases. The letter "L" specifies that this particular match was lost.

In the baseline phase, mean flow scores varied between 108.90 (Participants 2) and 153.50 (Participant 3). Overall, participants' flow states appeared to be substantially lower when the competition was lost. Following the intervention, flow state increased on average for Participants 1, 2, and 3, whereas Participant 4 showed a decrease. Participant 1 reported the strongest increase in mean flow experiences in the post-intervention phase by 22.90 points. His flow experiences became more stable, which is reflected in a smaller deviation from the mean, and there was a positive change in slope from baseline (M = 138.43) to post-intervention (M = 161.33) phase. Participant 2 reported the highest personal flow states in the three matches after the intervention. Even though Match 7 was lost, the flow score was higher than baseline scores. All flow-state scores in the post-intervention phase for Participant 2 stayed above the trend line ($M_{baseline}$ = 108.90; $M_{post\text{-}intervention}$ = 124.31). Although, Participant 3 reported the highest average flow score (M = 153.50) of all participants in the baseline phase, flow states were slightly higher following the intervention (M = 157.75). After the intervention, Participant 4 reported lower flow scores that reflected an ongoing negative trend across phases

($M_{baseline}$ = 120.71; $M_{post\text{-}intervention}$ = 107.63). When comparing the baseline with the post-intervention phase, the Binominal tests showed a significant increase in flow for Participant 1 (p < .001), Participant 2 (p < .001), and Participant 3 (p < .05) following the intervention. Only the results for Participant 4 were not significant (p = .125).

Service Performance in Competition

The results of the participants' service performance (SER) are presented in Figure 2. The lines bear the same meaning as in the presentation of flow state. The results of the service performances were calculated as percentage scores based on the ratio of service winners to service points played in total. The four participants showed an increase in service performance from baseline to post-intervention phase. Participant 1 improved in service performance across phases as reflected by the mean percentage score ($M_{baseline}$ = 7.85; $M_{post\text{-}intervention}$ = 13.03). Participant 2 revealed the strongest improvement in service winners, increasing from a mean of 4.35% to a mean of 24.12% in the post-intervention phase. The service performance showed a sustained increase after the intervention with only one overlapping data point. The trend in the post-intervention phase was still negative for Participant 2, but the trend line was close to horizontal. Participant 1 showed a negative performance trend in the baseline phase, which was reversed into a positive trend following the intervention. The highest percentage of service winners was reached in Matches 8, 9, and 10.

Participant 3 showed an increase in service performance from baseline to post-intervention phase of 5.04 mean percentage points ($M_{baseline}$ = 5.86; $M_{post\text{-}intervention}$ = 10.90). Even though the slope changed from a positive to a negative trend, three performance assessments in the post-intervention phase remained above the trend line. In addition, all post-intervention performances were above pre-intervention scores, indicating a sustained increase in performance and a positive intervention effect. For Participant 4, the service performance trend showed a strong negative slope before the intervention ($M_{baseline}$ = 6.85) and a near horizontal trend after the intervention ($M_{post\text{-}intervention}$ = 14.05). The Binominal test provided evidence that all four participants significantly improved their service performance in competition. The results showed a substantial improvement for Participants 1, 2, and 4 (p < .001), and a smaller, but statistically significant, increase for Participant 3 (p < .05).

Groundstroke Performance in Competition

As presented in Figure 3, all four participants increased their groundstroke performance after the imagery intervention. Participant 3 showed the strongest increase in groundstroke performance by 14.61 mean points from baseline to post-intervention ($M_{baseline}$ = 10.22; $M_{post\text{-}intervention}$ = 24.83). As the baseline performance showed a steep positive trend, the four post-intervention performances stayed below the extrapolated trend line. Given the improvement in mean groundstroke performance following the intervention, only one performance assessment overlapped with baseline performances, suggesting a positive intervention effect for Participant 3. For Participant 4 post-intervention performances partly ($M_{baseline}$ = 8.61; $M_{post\text{-}intervention}$ = 19.95) overlapped, whereas Participant 1 ($M_{baseline}$ = 12.90; $M_{post\text{-}intervention}$ = 16.66) and Participant 2 ($M_{baseline}$ = 10.53; $M_{post\text{-}intervention}$ = 16.26) revealed a large overlap between baseline and post-intervention groundstroke performances. For participants 3 and 4 the overlap mainly resulted from one positive outlier in the baseline phase, which potentially distorted the intervention effect. Binominal test results revealed that Participants 1 (p < .001), 2 (p < .05), and 4 (p < .001) significantly increased their groundstroke performance, whereas the performance of Participant 3 did not show a significant improvement across phases (p = .125).

Ranking List Development

Immediately after the completion of the post-intervention phase, participants' Australian junior ranking positions were assessed in comparison to the beginning of the baseline phase. Participants played all competition matches in official ranking-list tournaments conducted by Tennis Australia or Tennis Victoria. The four participants did not compete against each other and did not play any of their opponents twice. All matches were played against ranking-list players, except Matches 1 and 2 by Participant 1, and Match 8 by Participant 2. By the end of the study, Participant 1 increased his Australian National Junior ranking by 145 places from number 214 at the start of the study to number 69 by the end of the study. Participant 2 improved his ranking from 203 at the start to 176 at the end of the study, Participant 3 from 221 to 139, and Participant 4 from 244 to 173.

Social Validation Interview

Following the conclusion of the flow and performance data collection, a social validation interview was conducted with each of the participants separately. All participants expressed that working with the imagery script was a useful addition to their normal training routine and helpful in preparation for competition matches. Comparing reports of participants' flow experiences between pre- and post-intervention phases, three participants stated that several attributes of flow appeared to be stronger following the intervention, whereas Participant 4 reported no difference in his flow experiences. Participant 3 reported that flow experiences built up gradually during the match, and that the consistency of his performance was important for him to get into flow. Participant 2 stated that flow occurred rather automatically and was not triggered by a key situation. Participant 1 outlined that he often perceived an intense flow state at an early stage of the competition, even during warm-up. In general, participants' experience of using imagery was described as "stimulating". Participant 4, on the other hand, reported that working with the script had a more relaxing than stimulating effect on his match preparation, despite the lack of change in his perceived flow state. Overall, participants emphasized that imagery helped them to feel in control, to have clear goals, and to be able to focus better. For instance Participant 2 perceived as heightened and "exclusive concentration." Participant 1 also reported that he felt "more awake" and “more alert” when performing on court. He noticed he was more aware of what tactics his opponent used, how these tactics caused errors and mistakes to his game, and how he could counteract his opponent’s actions. In addition, all participants reported that their confidence had increased following the intervention.

Discussion

This study investigated the effectiveness of an imagery intervention developed on the basis of the relationship between types of imagery use and dimensions of flow to enhance flow state and competition performance in junior tennis players. None of the participants had systematically used imagery or worked with an imagery script before this study. Testing athletes’ imagery ability confirmed that participants had sufficient control over their images to effectively use the imagery script. The results showed evidence that cognitive and motivational imagery addressing key flow dimensions had a positive effect on flow state. Three participants displayed a mean increase in flow, and all participants improved their mean performance from baseline to post-intervention phase. These results are consistent with previous research, employing hypnosis (e.g., Lindsay et al., 2005; Pates et al., 2001) or imagery (Pates et al., 2003) to increase flow and performance in sports. The statistical analysis of the Binominal tests supported visual assessments, indicating that the majority of participants significantly increased their flow experiences and performances across phases. In this study, intervention effects were assessed in ecologically-valid conditions by examining the dependent variables in official ranking-list tournaments.

Using cognitive and motivation imagery types has been a fruitful approach to increase flow. Linking MG-M imagery with flow dimensions of challenge-skills balance and sense of control appeared to have a strong impact on positive experience, particularly on athletes’ confidence. For instance, Participant 1 noted that before the intervention he was repeatedly dwelling on lost points, whereas following the intervention he described his thoughts as "more proactive towards being positive" which enabled him to "make the shots when it was important." In addition, participants stated that they felt more focused and they knew what they wanted to do on court. It is possible that in anticipation athletes were better cognitively prepared to respond to various match situations. Additional research is necessary to address whether flow dimensions fulfil potential cognitive and motivational functions that are relevant for athletes' performance. For instance, clear goals and concentration on the task would predominantly involve cognitive processes, whereas autotelic experience would allow athletes to maintain intrinsic motivation in the task. The results of the study indicated that linking imagery types with specific flow dimensions has a positive effect on athletes' flow state in competition.

The results suggested that the imagery intervention was a valuable addition to the participants' off-court training routine and competition preparation. Morris et al. (2005) underlined the importance of imagery as a mental warm-up to achieve optimal readiness at the start of performance. According to Morris et al., athletes who imagine challenging match situations immediately before performing "will go into competition much more mentally alert and in the right mood state" (p. 220) than athletes who are mentally cold. In the social validation interview, three participants reported that the use of imagery led to feelings of being "pumped" and "psyched up." In addition, participants indicated that they felt more confident during the competitions. Using cognitive and motivational imagery as a mental warm-up before competition might have induced a positive pre-performance state that facilitated stronger flow experiences on court.

The only participant decreasing in flow after the intervention was Participant 4. In the validation interview, Participant 4 reported that he would have preferred an imagery script outlining performance situations that better suited his game. Even though he showed an acceptable level of adherence to the intervention, Participant 4's comments suggested that he was not highly committed to the intervention using a standardised script, which may have lowered the intervention effect. Callow and Hardy (2005) proposed that the meaning of the image could vary immensely between individuals, which might affect the outcome of the intervention. Developing individualised interventions might facilitate a positive attitude and commitment towards using imagery.

Limitations of the study have been identified with regard to the use of a single-case design, sample group, and the competition setting. First, between baseline and post-intervention phases there were considerable fluctuations in the intensity of flow and competition performance. The results showed that several outliers influenced the overall trends of flow and performance, which made it more difficult to evaluate intervention effects. For instance, Participant 3 reported relatively high flow scores within the baseline phase, leaving little room to gain a substantial increase in flow intensity. Therefore, the treatment effect for Participant 3 could have been clouded by a ceiling effect. It is noteworthy that single-case intervention studies conducted in a training setting have generally shown a distinct and sustained increase in flow and performance (e.g., Pates et al., 2002; Pates et al., 2001), whereas Lindsay et al. (2005) found inconsistent patterns of flow state and performance in cycling competitions. In this study, variability in flow and performance may derive from the ecologically-valid setting. Positive or negative outliers in the data affected the overall trend, particularly when low measurements occur at the end of the phase. In general, the results of the multiple baseline design confirmed similar findings across participants, although future studies should extend pre- and post-intervention phases, so that outliers have a smaller impact on the overall trend.

Second, the participants' young age could have raised concerns in conducting the intervention using a written script. The imagery script required concentrated and repeated reading at the beginning of the intervention, before participants were able to remember key aspects of the performance situations. Providing written information of the imagery contents could be perceived as challenging, as reported by one participant, before imagery sessions became smoother. Practitioners need to consider whether interventions with younger athletes are more effective if the imagery content is provided in script form or on audiotape. The use of audiotapes might provide a practical alternative that makes it easier for young athletes to get used to the intervention procedure.

Finally, the competition setting introduces potentially confounding variables affecting athletes' flow state. Situational factors vary between competitions, which can facilitate, prevent, or disrupt athletes' flow experiences (Jackson, 1995). Beside imagery, other factors, such as the competition situation or outcome, could have affected athletes' flow experience. The performance situation is characterised by a lack of control of extraneous variables, including opponents, weather, and audience, which may have had a substantial impact on flow and performance. In addition, the way athletes memorise and interpret events can augment or diminish the assessment of subjective experience (Brewer et al., 1991). The development and conduct of interventions on positive experience with strong ecological validity can be a challenging task for practitioners, although the benefits of fostering flow in young athletes has the potential to positively affect their enjoyment, motivation, and commitment to their sport.

For future studies, researchers need to assess the relationship between flow and performance in more detail to increase the understanding of possible causal links between these variables. Based on the approach and design of this study, there is no way of knowing whether the relationship between flow and performance is reflected by causality, reciprocity, or whether there is no consistent relationship between these variables, that is, each variable changes independently from the other. A fruitful approach would be to measure flow state during competition. Previous studies (e.g., Lindsay et al., 2005; Pates et al., 2002), as well as the current one, measured flow once after the event, whereas multiple measurements of flow and performance are needed to test for causal links between the variables. Jackson, Martin, and Eklund (2008) validated a nine-item short form of the Flow State Scale-2, which takes about a minute to fill out and could be completed repeatedly. In a tennis match, athletes could report on their flow state during match breaks when changing ends. The flow and performance patterns could be assessed in a time-series analysis. Patterns in which performance increased after flow would provide evidence for a one-directional connection in which flow directly affects performance. The opposite pattern would suggest a one-directional link with performance influencing flow. This approach would provide a better understanding if flow state drives performance, or whether performance drives flow.

In summary, the results of this intervention study were valuable, because of the administration of a tailored intervention and effectively implemented in ecologically-valid conditions. Based on previous findings (Koehn et al., in press) the intervention targeted a specific athlete group which aimed to enhance critical dimensions of flow in order to increase flow state and performance in tennis competitions. This study adds further evidence supporting the proposition that specific imagery types can be used to enhance flow state and performance in sport (e.g., Morris et al., 2005; Pates et al., 2003). Findings on the flow-performance relationship are not conclusive, and it is important that researchers increase efforts to further investigate possible causal links between flow state and performance. Future research would benefit from more theoretical work on the flow model (Kimiecik & Stein, 1992), such as the examination of three-way interactions between personal, situational, and performance variables influencing flow state that inform and guide prospective interventions.

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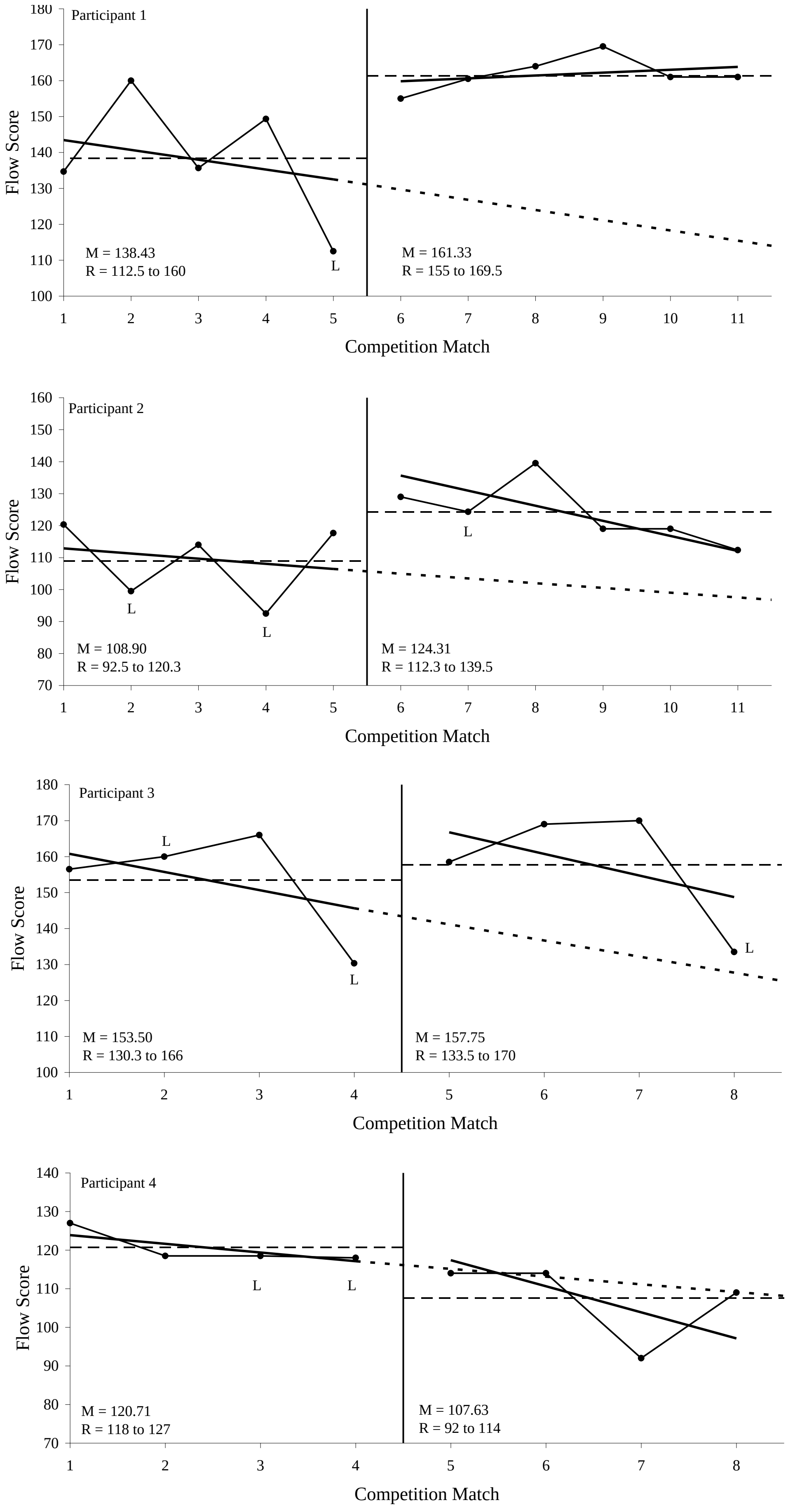

Figure 1. Flow State during the Baseline and Post-Intervention Phases.

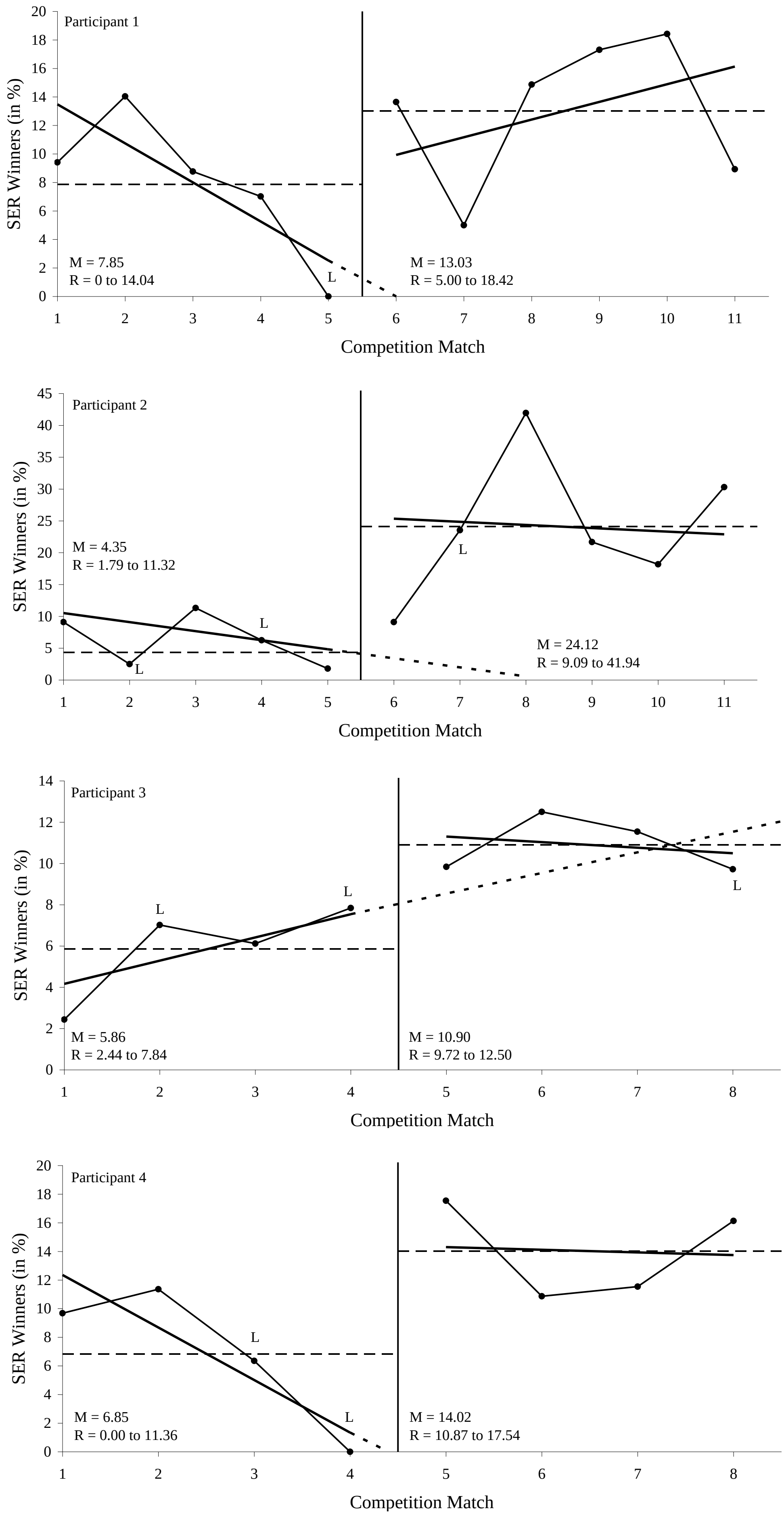

Figure 2. Service Performances across Baseline and Post-Intervention Phases.

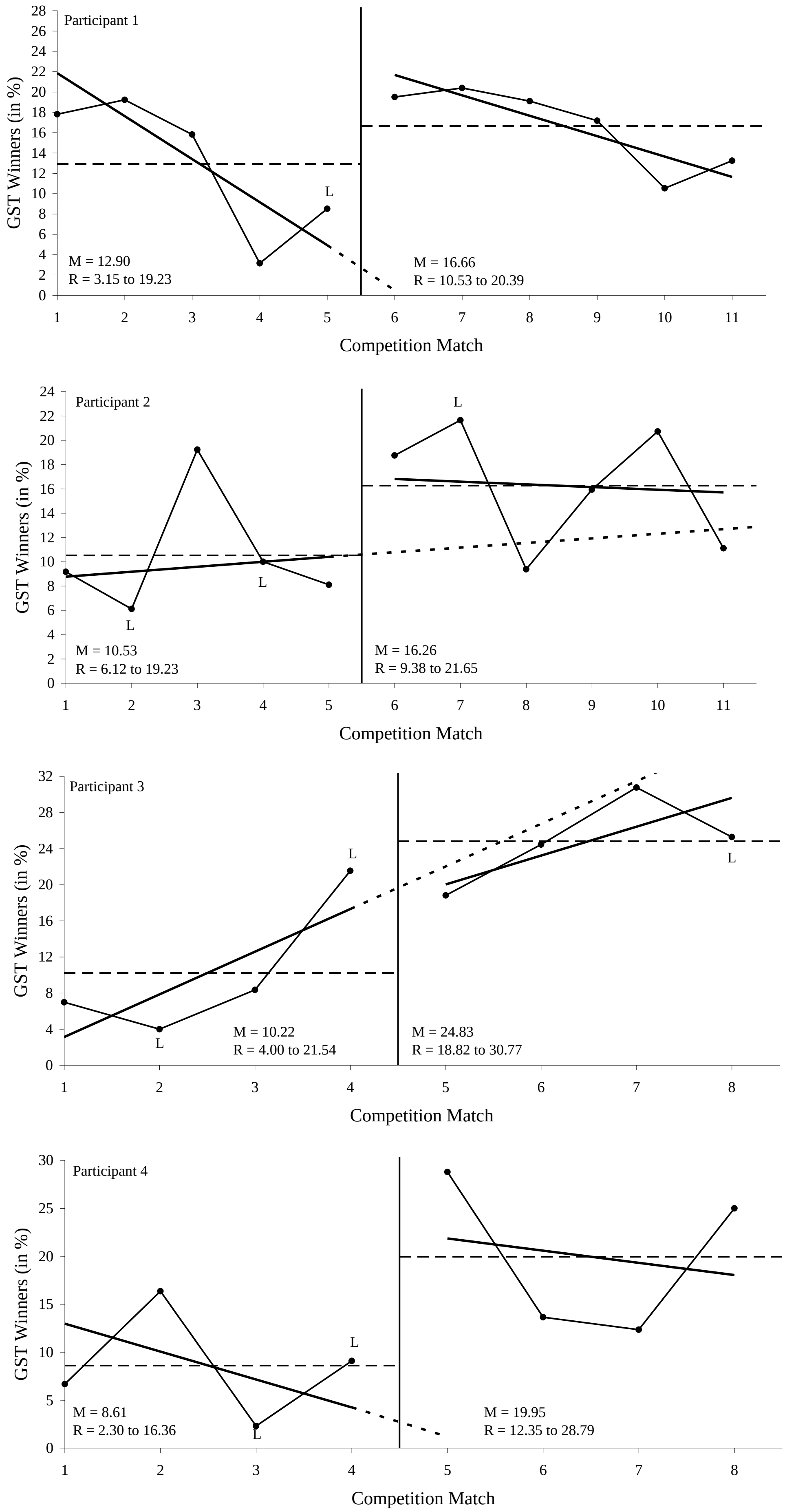

Figure 3. Groundstroke Performances across Baseline and Post-Intervention Phases.