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A Point-by-Point Analysis of Performance in a Fencing Match: Psychological Processes Associated With Winning and Losing Streaks

Julie Doron1 and Patrick Gaudreau2

1Paris-East Créteil University; 2University of Ottawa

This study aimed to revisit the complex nature of serial dependency of performance during a match, examining the prospective associations between psychological processes and subsequent performance at the within-person level of analysis, and explore whether psychological processes are associated with the likelihood of winning series of points. A process-oriented sequential approach was used with 16 elite fencers during a simulated competition. Multilevel regression analyses revealed that serial dependency of performance fluctuates within a match. Results of a Bayesian multilevel structural equation model showed that prior performance subsequently influenced psychological processes. Although psychological processes did not predict performance in the subsequent point, successive winnings were associated with higher perceived control and task-oriented coping and lower negative affectivity compared with both losing streaks and nonstreaks. Overall, serial dependencies of performance are nonstationary during a match whereas psychological processes significantly differ in episodes of winning after winning versus losing after losing.

Keywords: serial dependency, performance streaks, coping, perceived control, negative affectivity

Why does our timing seem just right on some days when we appear to be playing over our heads but on other days we are awkward and off balance? It is a wonderful experience when everything we do seems to be right. Many of us who engage in competitive sports, even those of us who are mediocre, wonder what accounts for these performance variations.

—Lazarus (2000, p. 236)

As eloquently expressed in this quote from Richard Lazarus, performance varies across days, matches, and even performance episodes within a match (e.g., sets in tennis, innings in baseball). Athletes have all experienced these ups and downs in their performance, sometimes rapidly alternating between flashes of brilliance and instances of mediocrity (e.g., Gaudreau, Nicholls, & Levy, 2010). As outlined by Lazarus (2000, p. 237), “these variations are what we want to understand.” The ongoing process-like nature of the relation between psychological processes and performance has recently been articulated more precisely in an episodic process model of performance (Beal, Weiss, Barros, & MacDermid, 2005). Accordingly, cognitive appraisals, affective states, and coping strategies have been conceptualized as core psychological processes to explicate within-person variations in performance across performance episodes. In this study, we focused on these processes because of their key positioning in contemporary theories of stress and coping (e.g., Hoar, Kowalski, Gaudreau, & Crocker, 2006; Ntoumanis, Edmunds, & Duda, 2009). Consistent with a transactional approach (e.g., Bandura, 1989; Sameroff, 2009), it can be argued that optimal psychological processes should not only be strengthened by prior winnings but that they could also influence subsequent performance. Hence, the goal of this study was to (a) revisit the ubiquitous yet complex nature of performance variability during a match, (b) examine whether performance influences subsequent levels of key psychological processes, and (c) explore whether higher than one’s own usual level of perceived control and task-oriented coping and lower than usual negative affectivity are associated with the likelihood of winning the subsequent point and series of points during a match.

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Sequential Dependency of Performance

A recent meta-analysis reviewed the empirical evidence of 22 studies that examined the “hot hand” phenomenon—or the extent to which an athlete should succeed on the next performance episode after having a series of successful performances (Avugos, Köppen, Czienkowski, Raab, & Bar-Eli, 2013). Meta-analytical estimate of the hot hand effect size was small and nonsignificant ($r = .02$), thus revealing the lack of association between prior performances and subsequent performance for both within-game and between-game analyses. Overall, these results suggest that the likelihood of getting good performance is neither boosted nor diminished by preceding performances.

Research on the hot hand phenomenon traditionally examines the effect of cumulative past successes (e.g., winning the last two points or more) on the subsequent performance. The development of psychologically relevant processes often follows a simplex pattern (e.g., Schutz, 1998) whereby adjacent time points (e.g., Time 1 and Time 2) are more strongly associated with one another compared with distal time points (e.g., Time 1 and Time 3). Performance at Time 1 is more likely to predict performance at Time 2 compared with performance at subsequent points. Acknowledging the possibility that sport performance could also follow a simplex pattern thus provides a methodological justification to investigate sequences of performance across two consecutive episodes of success (e.g., Hales, 1999). In this study, we adopted this alternative way of examining the sequential dependency of performance by examining the possibility that winning a point influences the likelihood of winning the subsequent point. On the one hand, winning a point might create immediate forward movement or volitional facilitation that could help winning the subsequent point. Such an effect would be consistent with a spillover effect wherein positive events foster the accumulation of resources and strengths to facilitate subsequent positive events (e.g., Fredrickson, 2001). On the other hand, winning a point might generate immediate coating or volitional inhibition which could negatively influence the likelihood of winning the next point. Such an effect would be consistent with a cybernetic model of self-regulation in which positive events are signals to reorient one’s self-regulatory resources toward other important personal goals (e.g., Carver & Scheier, 1998). In contrast, performance may act as a stationary binomial process in which the likelihood of winning a point remains constant across time, without being influenced by sequential dependencies (Jagacinski, Newell, & Isaac, 1979).

The meta-analysis of Avugos et al. (2013) revealed a largely heterogeneous effect size across the 36 samples of this review. However, type of sports (i.e., individual versus team) and performance lags (i.e., within-game versus between-game) did not moderate the serial dependency of performance. Serial dependency of performance might require a microscopic process-like analysis that would enable a more in situ examination of the co-occurring variations between ongoing psychological states and performance. In this study, we proposed that sequential dependency of performance might be an idiographic-nomothetic process likely to be influenced by timing and self-regulatory issues. In other words, it could vary across time for different individuals. For example, 12 of the 26 volleyball players in the study of Raab, Gula, and Gigerenzer (2012) exhibited a positive sequential dependency of performance; the performance of the other 14 players acted as a stationary binomial process.

Little is known about the episodic psychological processes associated with sequential dependency of prior performance (Time $t$) on the subsequent performance (Time $t + 1$) during competitive sport events. Multilevel modeling offers a useful framework not only to estimate the lagged auto-correlated association of performance across successive points in a match, but also to examine the associations between time varying psychological processes and ongoing natural within-person fluctuations in performance. Compared with statistical models traditionally used in the hot hand literature, multilevel models can readily investigate within-person associations between one’s psychological process and the likelihood of winning the next point. In multilevel modeling of within-person associations, each individual is compared with his or her own average (Nezlek, 2012), which inherently controls for “individual differences” in both performance and psychological processes. Multilevel modeling could also prove useful to examine whether the sequential dependency of performance fluctuates with the passage of time during a match. Serial dependencies of performance are often examined with statistical approaches that assume stationary effect across time points. In such analyses, the longitudinal pattern of performance is treated as an “omnipresent effect” (Bar-Eli, Avugos, & Raab, 2006; Wardrop, 1998) that ignores the likelihood that opposite “occasional effects” in the data might cancel each other out. A multilevel model could enable a test of nonstationarity to determine how serial dependency evolves during the course of a match. It might be that athletes are more prone to coasting after winning a point earlier in a match, as the outcome of winning or losing remains somewhat distant. As the match progresses, coasting tendencies might slowly dissipate and performance might start acting as a stationary binomial process. Such an episodic pattern of performance would be consistent with a “goal looms larger effect” (Touré-Tillery & Fishbach, 2011), in which each point would be more intensively battled as the outcome of the match become more proximal. Therefore, this study explored the likelihood that the sequential dependency of performance would vary across distinctive episodes/points within the course of a match.

Streaks Are Meaningful Units of Analysis

An important goal of this study was to evaluate the ongoing and fl levels of perceived control, negative affectivity, and task-oriented coping during a match. It has been argued that self-regulation and...
emotional processes are intricately tied with situational characteristics that unfold across different performance episodes (e.g., Beal et al., 2005; Lazarus, 2000). Yet, these psychological processes have traditionally been studied at the between-person level of analysis with the impetus to compare individuals rather than the same individual across successive events. Similarly, sport psychology research has mainly focused on individual differences in performance rather than on trying to explain what could explain within-person variations in performance across episodes of performance (e.g., Lazarus, 2000).

Although individual differences exist and are indeed worthy of scientific investigations, research examining the within-game (Schantz & Conroy, 2009) and between-game (Gaudreau et al., 2010) variations in performance have both indicated that a large amount of variance in performance is attributable to within-person variability. Furthermore, recent research has shown that athletes perform better than their average when they are using task-oriented coping more than their own average (Gaudreau et al., 2010). Athletes also experience more positive affective states than their own average after completing an episode during which they performed better than their own average (Schantz & Conroy, 2009). Therefore, an important goal of this study was to examine the within-person relationships between psychological processes and episodic performance. Some studies have already monitored changes in psychological processes during competition using a think-aloud protocol (Calmeiro, Tenenbaum, & Eccles, 2010; Nicholls & Polman, 2008) or a diary study (Gaudreau et al., 2010). However, these methods could potentially be contaminated by retrospective biases. Accordingly, we sought to develop and implement a process-oriented method that would minimize retrospective biases by measuring each of the psychological processes as they are experienced in situ by athletes between points during a match.

Winning streaks and the hot hand as well as losing streaks and the “cold hand” (Köppen & Raab, 2012) have sometimes been used interchangeably as synonyms to describe the same performance phenomenon. We believe that conceptual clarification is warranted because the presence and/or absence of positive/negative serial dependency does not overrule the fact that streaks of good and bad performances are still likely to happen during a game (Bar-Eli et al., 2006; Hales, 1999). It is not rare for athletes to consecutively win or lose a substantial number of points during a game. Yet, within-person fluctuations in performance—just like the occurrence of performance streaks—have traditionally been treated as unexplainable phenomenon attributable to chance (Kane & Lawler, 1979). In this study, we proposed that winning streaks, losing streaks, and nonstreaks (back-and-forth winning and losing) should be conceived as phenomenologically distinct performance episodes (Beal et al., 2005) likely to be associated with distinct psychological states. Although winning the subsequent point does not seem to be increased by the mere existence of a streak (i.e., hot hand), successive winnings might constitute a phenomenologically distinct performance episode associated with heightened perceived control and task-oriented efforts compared with losing streaks or episodes of back-and-forth winning and losing (i.e., nonstreaks).

This Study

The goal of this study was threefold. A first goal was to examine the serial dependency of performance across adjacent points (Time t + 1) in a game and the likelihood that the nature of the serial dependency could fluctuate as a game unfolds. A second goal was to investigate the within-person associations between psychological processes (i.e., perceived control, negative affectivity, and task-oriented coping) and performance at each point in the game. On the one hand, we examined the effect of performance at Time t on subsequent psychological processes experienced between the points of a match (measured before Time t + 1). On the other hand, we tested the effect of these psychological processes experienced between points in a game on subsequent performance at Time t + 1. A final goal was to test whether the psychological processes of athletes significantly differ across episodes of winning streaks, losing streaks, and nonstreaks during a match.

Method

Participants

A sample of 16 women elite saber fencers (M_{age} = 22.88 years, SD_{age} = 3.30) participated in this study. At the time of the study (i.e., 2008), the sample represented the entire national team of fencing (saber) from one of the G8 countries that competed in the phase of qualification of the Olympic Games in Beijing. Most of the athletes had competed at an international level and had taken part in several major international championships including the World Cup, the World Championships, and the Olympic Games. Elite athletes were purposefully sampled because their rigor and dedication toward their sport were making them good candidates to seriously comply with the requirements of a demanding research protocol involving multiple assessments during a match. All of the fencers agreed to participate in the research and signed the consent form before participating in this study. The protocol was also approved by the ethical committee of the National Fencing Federation.

Procedure and Measures

The data were collected during fencing simulated competition during a training session. The stakes associated with this simulated competition were multiple. First, given that it was the beginning of the phase of qualification for the Olympic Games, the fencers had to perform well during this simulated competition. Secondly, the coach observed athletes’ performances during these simulated competitions to inform the selection process for the roster
of the first World Cup event. Finally, the presence of the researcher was potentially stressful given that athletes’ performances were filmed and recorded for further analyses. Nevertheless, our findings should be interpreted within the confines of simulated matches, and determining if performance sequences are significantly altered by our research protocol (compared with real competitive matches) is a question in need of future investigation.

Before starting the training session, the researcher verbally gave the instructions and handed to each athlete a document that summed up the purpose of the study, the procedure-related instructions, and the measures. Participants read the measures and could ask questions to researchers to clarify the meaning of the words and expressions used to define and measure the psychological processes.

During the match, between each of the points, the two fencers had to individually complete the measures of perceived control, negative affectivity, and task-oriented coping and report their scores immediately after each point. Participants were specifically instructed to evaluate how they were feeling and coping at the current time, between the points, rather than during the previous point.

Thus, the data were obtained using multiple assessments of perceived control, negative affectivity, and task-oriented coping rated on a 100-mm visual analog scale (McCormack, Horne, & Sheather, 1988) immediately after each point during the entire match. Each participant had access to a table, a pen, and the questionnaire to facilitate participation. After each point (immediately after referee decision), athletes returned to the table, completed the measures, and continued the match. Matches were won when one of the two fencers had won 15 points.4

A single-item definitional approach (Ptacek, Smith, Espe, & Raffety, 1994; Raffety, Smith, & Ptacek, 1997; Stone & Neale, 1984) was used to measure perceived control, negative affectivity, and task-oriented coping. In the definitional approach, which has been used in other studies on coping (Ptacek, Smith, & Zanas, 1992; Ptacek et al., 1994; Raffety et al., 1997; Smith & Christensen, 1995; Stone & Neale, 1984), the key conceptual features of a construct are summarized into a brief paragraph on which participants are asked to provide a single rating. Previous research has demonstrated the convergent validity of definitional measures of coping (Ptacek et al., 1994), while showing the usefulness of this approach to collect data in longitudinal intensive designs and other situations that would make it impractical for participants to repeatedly complete more traditional multi-item scales.

In this study, each definitional item was created from definitions used in past theories and empirical studies (e.g., Gaudreau & Blondin, 2002; Skinner, 1996; Watson, Clark, & Tellegen, 1988). Perceived control was measured with this stem: “A game situation involves several aspects. It is possible to change or to master some of these game situations. It is also possible not to be able to change or master other aspects of a game situation. Thus, perceived control represents the feelings you have regarding your capacity to change or to master game situations.”

Negative affectivity was evaluated by asking athletes to rate the extent to which they currently felt “distressed, annoyed, scared, guilty, nervous, afraid, anxious, etc.”

Finally, Task-oriented coping was measured with this stem: “Task-oriented coping represents the means that you are using to manage a game situation or to solve a problem you are facing in the match. It includes efforts to concentrate, to seek information or advice from the training staff, to analyze the point, to manage your time in a point, to enhance your effort, to manage your goals, to identify solutions, to create and use a plan of actions to make your actions more efficient, etc.”

Psychological processes were expected to display both change (within-person differences) and stability (between-person differences; Gaudreau & Miranda, 2010). Results of intraclass correlation (ICC) indicated that a significant amount of variance in perceived control (ICC = .438), task-oriented coping (ICC = .359), and negative affect (ICC = .577) was attributable to between-person differences. Yet, the rest of the variance was attributable to point-by-point variations that occurred during the match, thus showing that our single-item measures were capable of capturing the point-by-point fluctuations in each of the psychological processes of this study.

### Results

#### Sequential Dependency of Performance

A logistic multilevel regression (Hox, 2010) was conducted to determine the lagged association between performance at Time $t$ (losing the point $= 0$; winning the point $= 1$) and performance at Time $t + 1$ (losing the subsequent point $= 0$; winning the subsequent point $= 1$). A null model was tested to estimate the grand mean of the proportion of points lost during the match of the 16 participants. Performance at Time $t$ was entered as a predictor in a second model followed by time in a third model. Time was centered at the first point of the match, whereas performance at Time $t$ was within-person centered. Finally, the performance at Time $t \times$ time interaction was entered in a fourth model that followed this equation:

**Level 1:**

$$\text{Logit} [\Pr (\text{Win } t + 1 | X_i)] = \pi_{00} + \pi_{10} (\text{performance } t_i) + \pi_{20} (\text{time } r_i) + \pi_{30} (\text{performance } t_i \times \text{time } r_i)$$

**Level 2:**

$$\pi_{00} = \beta_{00} + r_0$$

$$\pi_{10} = \beta_{10} + r_1$$

$$\pi_{20} = \beta_{20} + r_2$$

$$\pi_{30} = \beta_{30} + r_3$$

In this model, $\beta_{00}$ represents the average winning rate for the individuals in the sample in the log-odds
metric, $\beta_{10}$ denotes the average effect of prior performance (Time $t$) on the subsequent performance at Time $t + 1$ for individuals in the sample; $\beta_{30}$ is the average linear trajectory of performance during the match, and finally, $\beta_{10}$ represents the average moderating effect of time in the relation between prior performance (Time $t$) on the subsequent performance at Time $t + 1$. In this model, all of these effects were free to vary across individuals (i.e., random effects $r_0$ to $r_3$).

Applying the exponential transformation to the grand mean estimate ($\beta_{00}$) from the null model (Hox, 2010, p. 123; $e^{\beta_{00}} / 1 + e^{\beta_{00}}$) revealed that approximately 50% of the points were won during the games played by the 16 fencers (see Table 1, Model 1). Results of the second model indicated that fencers were significantly less likely to win a subsequent point at Time $t + 1$ after winning the point at Time $t$. Applying the exponential transformation to these parameters revealed that fencers were winning 48% of the time after losing a point, whereas they were winning 36% of the time after winning a point. In Model 3, there was no significant effect of time on the likelihood of winning the point at Time $t + 1$. However, the effect of prior performance at Time $t$ on the $t + 1$ performance was significantly moderated by the passage of time within a match (see Table 1, Model 4). This interaction was plotted at different times during the match (point 2 to point 30) to examine the shape of the relationship between prior performance and subsequent performance (see Figure 1). At the start of the match (point 2), the relationship between prior and subsequent performance was negative and significant ($\beta_{10} = -1.327, SE = 0.203, p < .05$; $\beta_{00} = 0.202, SE = 0.166, p > .05$). This relationship became nonsignificant between the 16th ($\beta_{10} = -0.437, SE = 0.184$, $p < .05$; $\beta_{00} = -0.005, SE = 0.126, p > .05$) and 17th point of the match ($\beta_{10} = -0.405, SE = 0.190, p > .05$; $\beta_{00} = -0.012, SE = 0.129, p > .05$). At the end of the match (point 30), the relationship was positive yet nonsignificant ($\beta_{10} = 0.452, SE = 0.378, p = .25$; $\beta_{00} = -0.212, SE = 0.250, p > .05$). Results displayed in Figure 1 indicate that the serial dependency of performance is significantly attenuated with the passage of time in a match, with earlier phases of a game being characterized by a volitionally debilitating coasting-like serial dependency and later phases of a game being characterized by a stationary-like binomial process.

**Psychological Processes and Episodic Performance**

**Plan of Analyses.** A Bayesian multilevel structural equation model (MSEM) was performed to simultaneously examine (a) the effect of Time $t$ performance on each of the three psychological processes measured immediately after Time $t$ (i.e., between the Time $t$ and Time $t + 1$) and (b) the effect of each psychological process on subsequent performance at Time $t + 1$. The MSEM was deemed as an appropriate analytical strategy to simultaneously estimate all parameters, thus avoiding problems associated with conducting several nonindependent multilevel random regressions (i.e., one for each dependent variable). Several reasons favored the utilization of the Bayesian estimator rather than the more traditional maximum likelihood estimator. First, accurate Bayesian estimation can be obtained with very small samples, thus making MSEM appropriate whenever few people (i.e., Level-2 units) meet eligibility criteria for participation in a study (Hox, van de Schoot, & Mattijsse, 2012). Second, MSEM can become impracticable in models containing both continuous (i.e., psychological processes) and categorical (i.e., win/lose) dependent variables. Bayesian estimators are more flexible and efficient than traditional estimators (e.g., Muthén & Asparouhov, 2012) because they are more likely to converge and are less susceptible to provide untrustworthy

![Figure 1](image-url)
parameter estimates (e.g., negative error variance). Third, MSEM should preferably incorporate random effects to determine the extent to which a relation between two variables (i.e., slope) varies across individuals (i.e., Level-2 units). The Bayesian estimator inherently assumes that all parameters are random, whereas likelihood-based approaches rely on a computationally demanding numerical method to integrate random effects (Preacher, Zyphur, & Zhang, 2010). An MSEM with random effects often fails to converge with the maximum likelihood estimator. Failure to incorporate random effects in a model can alter the fixed effects and their statistical significance, thus biasing substantive interpretation of research findings (Nezlek, 2012). As such, the Bayesian estimator is more flexible than the maximum likelihood estimator because it inherently facilitates the inclusion and estimation of random effects in a complex MSEM. Our Bayesian MSEM was estimated using Mplus Version 7 with the default specification to use uninformative priors. Therefore, the parameter estimates reported hereafter are only a function of the current data (rather than a combination of informative priors with the information from the current data). This decision was justifiable given the small sample (Hox et al., 2012) and our relatively limited prior knowledge about the size of the effects to be estimated in the current study.6

Results of the Bayesian MSEM. Although our hypotheses were all at the within-person level, the Bayesian MSEM allows for the simultaneous estimation of the proposed associations at the within-person and between-person levels of analysis. The covariance between the three psychological processes was incorporated in the model by correlating their error terms. The within-person effects were free to vary across individuals (i.e., random effects). A first model incorporated all the paths at both the within-person and between-person levels. All paths at the between-person level were not significant and were therefore excluded from further analyses. Results of the second model, which focused exclusively on the within-person level, are displayed in Figure 2. The results indicated that winning the Time t point was associated with higher subsequent perceived control and task-oriented coping and with lower subsequent negative affect. In contrast, none of the three psychological processes, measured and experienced between the points, was significantly associated with losing or winning the subsequent point at Time t + 1. The random effects of the within-person associations were all significant, thus indicating that relationships between psychological processes and episodic performance differed across individuals in the sample.

Figure 2 — Bayesian multilevel structural equation model: Independent and dependent variables were coded (0 = losing; 1 = winning). Between-person associations were nonsignificant and excluded from the model (i.e., fixed to zero). All parameters are unstandardized. Random effects are reported in parentheses. Covariances between the mediators were significant at the within-person level. **p < .01; *p < .05. All p values are one tailed.
### Table 1  Multilevel Logistic Regression of Performance at Time $t + 1$

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
<th>Model 3</th>
<th></th>
<th>Model 4</th>
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<tbody>
<tr>
<td></td>
<td>Estimate (SE)</td>
<td>OR</td>
<td>Estimate (SE)</td>
<td>OR</td>
<td>Estimate (SE)</td>
<td>OR</td>
<td>Estimate (SE)</td>
<td>OR</td>
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<tr>
<td>Fixed effect</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>$\beta_{00} = $ Intercept</td>
<td>$-0.011$ (0.122)</td>
<td>1.011$^a$</td>
<td>$-0.008$ (0.123)</td>
<td>1.008$^a$</td>
<td>$0.180$ (0.191)</td>
<td>1.197</td>
<td>$0.217$ (0.197)</td>
<td>1.242</td>
</tr>
<tr>
<td>$\beta_{10} = $ Prior performance at Time $t$</td>
<td>$-0.416^*$(0.196)</td>
<td>1.515$^a$</td>
<td>$-0.501^*$(0.200)</td>
<td>1.650$^a$</td>
<td>$-1.391^{**}$(0.390)</td>
<td>4.016$^a$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{20} = $ Time</td>
<td>$-0.014$ (0.014)</td>
<td>1.014$^a$</td>
<td>$-0.015$ (0.013)</td>
<td>1.015$^a$</td>
<td>$0.064^*$(0.024)</td>
<td>1.066</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta_{30} = $ Prior Performance $\times$ Time</td>
<td>$0.180$ (0.191)</td>
<td>1.197</td>
<td>$0.217$ (0.197)</td>
<td>1.242</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Random effect</td>
<td>Variance</td>
<td></td>
<td>Variance</td>
<td></td>
<td>Variance</td>
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<td>Variance</td>
<td></td>
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<tr>
<td>$r_0$</td>
<td>0.096$^*$</td>
<td></td>
<td>0.092</td>
<td></td>
<td>0.012</td>
<td></td>
<td>0.002</td>
<td></td>
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<tr>
<td>$r_1$</td>
<td>0.012</td>
<td></td>
<td>0.011</td>
<td></td>
<td>0.004</td>
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<td>0.001</td>
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<tr>
<td>$r_2$</td>
<td>0.001</td>
<td></td>
<td>0.001</td>
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<td>0.001</td>
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<td>0.001</td>
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<tr>
<td>$r_3$</td>
<td>0.001</td>
<td></td>
<td>0.001</td>
<td></td>
<td>0.001</td>
<td></td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

Note. OR = odds ratio. Points lost are coded as 0. Points won are coded 1. Parameters are unstandardized.

$^a$Reciprocal of the OR to facilitate interpretation of effect size. $^*$p < .05; $^{**}$p < .01.

### Table 2  Multilevel Multinomial Regression of Losing Streaks, Winning Streaks, and Nonstreaks

<table>
<thead>
<tr>
<th></th>
<th>Losing Streaks vs. Nonstreaks</th>
<th>Winning Streaks vs. Nonstreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept ($\beta_{00}$)</td>
<td>Predictor ($\beta_{10}$)</td>
</tr>
<tr>
<td></td>
<td>Estimate (SE)</td>
<td>OR</td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_1 = $ Perceived control</td>
<td>$-0.978^{**}$(0.193)</td>
<td>2.660$^a$</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_1 = $ Negative affectivity</td>
<td>$-1.029^{**}$(0.148)</td>
<td>2.793$^a$</td>
</tr>
<tr>
<td>Model 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi_1 = $ Task-oriented coping</td>
<td>$-0.931^{**}$(0.185)</td>
<td>2.538$^a$</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio. Parameters are unstandardized.

$^a$Reciprocal of the OR to facilitate interpretation of effect size. Random parameters were estimated but not reported in this table; they are available upon request. $^*p < .05; ^{**}p < .01.$
Psychological Processes and Performance Streaks

The first point in a game was not used in these analyses because it could not be won after winning or lost after losing. Out of the remaining 472 points, a total of 115 points (24.3%) were won after winning a point (i.e., winning streaks), 108 points (22.8%) were lost after losing a point (i.e., losing streaks), and 249 points (59%) were either won after losing or lost after winning a point (i.e., nonstreaks). Our analyses examined whether psychological processes measured between Time t and Time t + 1 predict points lost after losing (coded as 0), points won after winning (coded as 1), and points won or lost outside of a streak (coded as 2) during the subsequent point at Time t + 1. Three multinomial multilevel regressions were conducted to estimate the role of each of the three psychological processes in predicting (a) points lost after losing versus points won or lost outside of a streak and (b) points won after winning versus points won or lost outside of a streak (see Table 2).7

Task-oriented coping and perceived control between Time t and Time t + 1 significantly reduced losing after losing compared with winning or losing outside of a streak.8 Low and high levels of task-oriented coping (1 SD below and above one’s own average) resulted in 34.9% versus 21.1% of losing after losing. Low and high levels of perceived control resulted in 40.2% versus 17.4% of losing after losing. In contrast, negative affectivity between the points significantly increased losing after losing compared with winning or losing outside of a streak. Low and high levels of negative affectivity (1 SD below and above the mean) resulted in 41.6% versus 42.8% of losing after losing. Overall, higher task-oriented coping and perceived control as well as lower negative affectivity (compared with one’s own average) reduced the likelihood of successive failures during a match.

Task-oriented coping and perceived control between Time t and Time t + 1 significantly increased winning after winning compared with winning or losing outside of a streak. Low and high levels of task-oriented coping (1 SD below and above one’s own average) resulted in 15.7% versus 39.6% of winning after winning. Low and high levels of perceived control resulted in 17.1% versus 37.3% of winning after winning. Negative affectivity significantly decreased winning after winning compared with winning or losing outside of a streak. Low and high levels of negative affectivity (1 SD below and above one’s own average) resulted in 36.2% versus 18.6% of winning after winning. Overall, higher task-oriented coping and perceived control as well as lower negative affectivity (compared with one’s own average) increased the likelihood of successive winnings during a match.

Discussion

Results of this study indicated that fencing performance did not follow a volitionally facilitative pattern (i.e., hot hand) in which winning increases the likelihood of winning the subsequent point. In contrast, the general trend revealed a coasting-like volitionally inhibiting sequential dependency in which fencers were more likely to lose the next point after winning the previous point. More precisely, fencers were winning 48% of the time after losing a point, whereas they were winning 36% of the time after winning a point. This finding differs from past studies in which subsequent performance was mostly found to be unaffected by previous performance (e.g., Avugos et al., 2013). However, this main effect should be interpreted cautiously because it was significantly attenuated by the passage of time within a match. More precisely, the coasting-like volitionally inhibiting sequential dependency slowly dissipated as the match progressed before becoming nonsignificant at some point during the second part of the match. It thus seems like a point-by-point analysis provides a unique account of a time-contingent or nonstationary serial dependency that fluctuates across time in a match.

In sport psychology research, considerable emphasis has been placed on understanding and explaining the relationship between psychological factors and performance (e.g., Smith & Christensen, 1995), but most research has focused on between-person differences in performance (e.g., Gaudreau et al., 2010). In the current study, we revisited these hypotheses at the within-person level of analysis. In these analyses, each individual is compared with his or her own average, which inherently controls for base rates of performance, or what we might also call “individual differences” in both performance and psychological processes. As posited in the episodic model of human performance (Beal et al., 2005), within-person variations in the quality of outcomes (i.e., performance) are mainly influenced by co-occurring self-regulatory resources and affective states. Results of our study showed the intricate but complex associations between psychological processes and performance. Subsequent perceived control, task-oriented coping, and negative affect experienced between points were predicted by prior performance. Winning does put the athletes in a different mindset. However, none of the three psychological processes experienced between points predicted performance in the subsequent point of a match at Time t + 1. It thus seems like perceived control, coping, and negative affectivity experienced between the points does not predict performance in the next point. This result is consistent with a binomial stationary process in which past performance, which heightens the psychological processes, does not generate volitional facilitation that could significantly increase performance on the subsequent point. The increase in psychological processes consecutive to winning a point does not translate into an increased or decreased likelihood of winning the next point, thus contradicting tenets of both the spillover (i.e., reciprocal determinism, transactionalism) and cybernetic control theoretical approaches. Yet, results of the Bayesian MSEM indicated that the prospective associations between psychological processes and subsequent performance significantly varied across individuals in our
sample (i.e., random effects). Therefore, future research should start examining potential moderators to discover under which circumstances and for whom psychological processes can create volitional facilitation versus volitional inhibition.

At a first glance, it could be tempting to conclude that psychological processes are inconsequential for performance. Such interpretation proved to be incomplete in this study. Although psychological processes did not predict performance in the next point, this study showed their value in differentiating winning versus losing points in succession. As such, our results using performance streaks as the unit of analysis revealed that psychological processes are significantly different in episodes of winning after winning versus losing after losing. More precisely, higher than one’s own average of task-oriented coping and perceived control and lower negative affectivity were associated with higher likelihood of winning the subsequent point after having won the previous point (i.e., winning streak). Furthermore, lower than one’s own average of task-oriented coping and perceived control and higher negative affectivity were associated with higher likelihood of losing the subsequent point after having lost the previous point (i.e., losing streak). These results indicate that psychological processes become significantly associated with future performance only when predicting winning after winning (i.e., winning streak) and losing after losing (i.e., losing streak). In other words, performance in streaks does offer a meaningful level of analysis to understand the role of psychological processes in within-person variations in performance.

**Limitations and Future Studies**

Serial dependencies in performance within a game are inherently complex. They could vary across sports (Raab et al., 2012) and, as shown in this study, they could fluctuate with the passage of time in a match. This study was conducted with a small sample of elite fencers. Samples of elite athletes are inherently homogeneous, thus limiting the generalizability of our findings. Future research should try to replicate these findings in other sports or with fencers at different levels of expertise. As such, it is important to highlight that fencing is subdivided in specialties such as saber, foil, and épée. Matches in saber are won when one of the fencers has accrued 15 points, whereas matches in épée or foil are time-bounded and require time-management skills. Our findings could be replicated in épée or in foil as the coasting-like volitionally debilitating serial dependency observed early in saber matches might be more detrimental and less likely to occur given the time-bounded nature of the épée or foil matches.

Data were collected during simulated competitive matches performed in training sessions. Although these matches involved fencers of comparable skills and expertise, the level of importance and perceived stress may have been lower than in regular fencing competitions. In addition, multiple assessments during a match could have altered the ongoing psychological processes and performance of the athletes. However, it would be ethically and methodologically challenging to assess coping, perceived control, and negative affectivity immediately after each point during a real sport competition. Future studies of serial dependencies in real competitions could nonetheless adopt video methodologies or a think-aloud protocol (e.g., Calmeiro et al., 2010; Nicholls & Polman, 2008) to retrospectively ask participants to recall their psychological states after each point. In addition, what fencers do to cope during points could be also investigated. It would be interesting to determine if athletes cope differently between points compared with during points and whether the latter usage of coping is a stronger predictor of subsequent performance. Furthermore, future studies could also complement self-reported measures of psychological processes with ongoing monitoring of physiological stress responses to triangulate our findings using a multimethod measurement scheme.

Coping is a multidimensional construct. In the current study, a single item was used to measure task-oriented coping. Future research should either use more traditional coping measures or expend the definitional approach to incorporate some strategies, such as relaxation, in the description of task-oriented coping. Furthermore, empirical attention will need to be allocated to distraction- and disengagement-oriented coping, which were omitted in the measurement scheme used in the current study.

Experimental manipulations could also help us to understand the complex associations between psychological processes and performance. For example, athletes could be randomized either in a control or a coping intervention group (e.g., Achtziger, Gollwitzer, & Sheeran, 2008) to determine if individuals in the experimental condition would be more likely to experience winning streaks rather than losing streaks. Furthermore, future studies could investigate whether stable personality dispositions and motivational orientations could moderate the temporal patterns of performance in a match. Athletes with high levels of pessimism or perfectionism might be more prone to react negatively after losing a point, which could exacerbate the likelihood of losing a point after having lost the prior point (i.e., losing streaks). Overall, the point-by-point approach used in this study offers a framework to further our understanding of the role of complex person-by-situation interactions in the within-person ups and downs of performance during matches. However, our findings should be interpreted within the confines of simulated matches, and determining if performance sequences are comparable in real competitive matches certainly deserves future empirical investigations.

**Conclusion**

The performance of fencers fluctuates within a match. Although fencers are not more likely to win the subsequent point after winning the prior point, performance
streaks do happen in the course of fencing matches. Twenty-four percent of the points were won after winning a point (i.e., winning streaks), 22.8% were lost after losing a point (i.e., losing streaks), and 59% were either won after losing or lost after winning a point (i.e., nonstreaks). Our results outlined that successive winnings (i.e., winning streaks) are associated with higher levels of perceived control and task-oriented coping and lower levels of negative affectivity compared with both losing streaks and nonstreaks. These results indicate that consecutive wins are phenomenologically distinct performance episodes during which optimal psychological processes are heightened compared with other episodes during which the athletes successively alternate between winning and losing points. Performance streaks offer a meaningful and complementary unit of analysis to investigate performance in sport psychology research.

Notes

1. Most studies on associations between coping and objective indicators of performance reported that task-oriented forms of coping were positively associated to objective performance (e.g., Gaudreau et al., 2010; Haney & Long, 1995; Van Yperen, 2009). For example, task-oriented forms of coping were associated with the golfers’ most successful rounds (Gaudreau et al., 2010), the numbers of points in a free-throw task (Haney & Long, 1995), the seasonal batting average of professional baseball players (Smith & Christensen, 1995), and career success in professional soccer (Van Yperen, 2009).

2. The simulated competition, conducted before the period of the Olympic Games team selection, entailed several characteristics (i.e., motivated performance task, the presence of the researcher, the observations by the coach, recording the performance on video) known to induce psychosocial stress (e.g., Dickerson & Kemeny, 2004).

3. The saber is one of the three weapons in modern fencing. The saber differs from the other weapons (épée and foil) because it is possible to score with the edge of the blade; for this reason, movements and attacks in saber are very fast. Like foil, saber uses the convention of right-of-way to determine who acquires the touch. The target area for saber consists of the torso above the waist, as well as the arms and head (excluding both hands).

4. Participants were Francophone. These items were translated only for the purpose of describing the method to English-speaking readers. French items are available under request. Complementary analyses indicated that these results were not significantly moderated by winning or losing the match ($p = .93$) or by point dispersion during the match ($p = .95$; points ahead or points behind in the match).

5. Fit indices are currently not available to evaluate and compare models via Bayesian MSEM in Mplus because they do not start with an independent model assuming that all parameters are null. The fit indices are traditionally computed upon such a model.

6. Given the small sample, this approach was preferred to a multivariate model in which all predictors are simultaneously included to predict unique variance in the dependent variable. Our analyses focused on the two most relevant comparisons (nonstreaks with the winning and losing streaks, respectively) because multinomial regressions cannot compare the three levels of the dependent variable as in a multiple comparison.

7. These analyses used the entire rating scale of the independent variable. However, as suggested by Nezlek (2012), we calculated the predicted values of the dependent variable (in percentage) at low (−1 SD) and high (+1 SD) values of the independent variable to help readers grasping both the direction and the size of the effect.

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