The intricacies of verbalizations, gestures, and game outcome using sequential analysis

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A B S T R A C T

Objectives: The purpose of the present study was to identify the intricacies of verbalizations, gestures, and game outcome during competition.

Design: The behavioral research software Observer XT® using sequential analysis was used to analyze our data.

Method: Participants were 34 junior tennis players with a mean age of 13.68 (SD = 1.8). Youth players were observed during 17 matches using the Self-Talk and Gestures Rating Scale and were examined by a built-in application (Observer XT®) of mapping of verbalizations, gestures, and performance.

Results: Sequences indicated negative verbalizations were the most frequently exhibited form of overt verbalizations, followed by positive and instructional verbalizations. Furthermore negative verbalizations for either the server or the receiver decreased the probability of winning a game and showed verbalizations from the server related to the receiver’s verbalizations and game outcome, and vice versa.

Conclusions: The results shed light on how verbalizations and gestures interact differently according to the context, which may have important implications for research that has focused on verbalizations and has neglected gestures and contextualized performance in sport.

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The link between thought and action is a subject for inquiry from philosophy (Plato, trans. 1993) to pioneer cognitive psychologists (e.g., Neisser, 1967). Vygotsky (1986) argued that “the area of inner speech is one of the most difficult to investigate” (p. 226). Furthermore, Davids and Araújo (2010) proposed that research should not solely focus on the role of conscious mental life but also on the role of the environment in regulating thoughts and behavior. Eccles (2012) in his review on verbal reports noticed that researchers should take into consideration the conditions under which participants can provide useful responses of their cognitive processes. Davids and Araújo (2010) were aligned with Reed (1996) who argued that verbalizations, expressed following appropriate procedures, are a means of selecting and making information available to others and to oneself. Verbalizations refer not only to inner representations but also to environmental situations and states of affairs that the person who verbalizes is presenting to others (Reed, 1996). When people verbalize their thoughts they frequently gesture. Gestures and verbalizations have been assumed to reflect a person’s feelings and emotions (e.g., Beilock & Goldin-Meadow, 2010) and these verbalizations affect not only the speaker but also the listener (e.g., Goldin-Meadow & Alibali, 2013). Furthermore, Beilock and Goldin-Meadow (2010) relying on the embodied-cognition framework (e.g., Wilson, 2002), revealed that gestures had an effect on one’s subsequent performance. Sport competition is a context in which numerous gestures and verbalizations occur in different moments under different situations. Thus, based on Beilock and Goldin-Meadow’s (2010) results and their suggestions that the mechanisms underlying the relationships between one’s gestures and thoughts are unclear (Goldin-Meadow & Beilock, 2010), our wider aim was to examine the interplay between an athlete’s gestures and verbalizations and their effects on the opponent’s gestures, verbalizations, and performance in the
naturalistic setting of tennis competition based on an ecological and embodied theoretical approach (Gibson, 1979).

Ecological approach and verbalizations

The ecological approach assumes that knowledge about the world is actualized through the complex and ever-changing relationship of person-as-knower to the environment-as-known. This approach calls for a complete understanding of the informational aspects of the ecological niche, as well as the behavioral consequences of such information, thus bridging the alleged gap between perception, action, and knowledge (Gibson, 1979). Gibson (1966) distinguished between knowledge of the environment (perception based on information to control action, which constrains actual action; for example, “what do I do to achieve a certain goal when I'm playing the tennis point?”) and knowledge about the environment (perception mediated by language, pictures and other symbols, which constrains future action; for example, “what can I tell you, or show you, now, that I'll do in the next tennis point?”). This distinction has profound implications in sport (see Araújo, Davids, Cordovil, Ribeiro, & Fernandes, 2009). Performers can perceive themselves, their environments, and the changing relationship between themselves and their surroundings. The perception of the action possibilities of the environment is what Gibson means by “knowledge of” the environment. It is not formulated in pictures or words, for it is this knowledge that makes the formulation of pictures and words possible. Information is available in the environment, and it can be picked up by many observers. On the other hand, images, pictures, and words afford a mediated, indirect knowledge, that is, knowledge about the world (Gibson, 1979). This kind of knowledge is intrinsically shared, because it involves displays of information to others. Verbalizations and gestures are examples of this. The value of these sentences with selected samples of information about the ecology does not lie in the words themselves, but in what they refer to in the circumstances they are expressed. They consolidate gains of perception by converting tacit knowledge into explicit knowledge (Reed, 1991). The role of explicit knowledge, and the processes that make knowledge explicit, is not to create knowledge out of merely potentially meaningful input, nor even to select meanings to assign to inputs. The role of explicit knowledge, as Goldin-Meadow and Beilock (2010) argue, is to make others, and maybe the speaker him/herself, aware. Gestures and verbalizations are means to share knowledge. The question is how functional (i.e., beneficial for performance) this is, for the one who shares. Based on this theoretical rationale it was expected that the relationship between gestures, verbalizations, and game outcome to be dependent on circumstances.

Gestures and verbalizations

Individuals use gestures when they talk and these gestures may facilitate speaking (Iverson & Goldin-Meadow, 1998). Gestures have been found to play an important role in a variety of settings and domains (for review see, Goldin-Meadow & Alibali, 2013). For example, in a recent meta-analysis conducted by Hostetter (2011) a moderate effect size of the beneficial effect of gestures on language comprehension was found. Recently, Beilock and Goldin-Meadow (2010) argued that gestures “force” people to think with their hands. They also suggested that one's own gestures can have an impact on one's subsequent performance and that they can facilitate thinking. More specifically, they revealed that gesture's effect on thought was not carried by speech but gesturing had an effect on performance. However, as Goldin-Meadow and Beilock (2010) suggested, action gestures (e.g., the motion of the stroke in tennis) can change not only the way listeners think but also the way gestures themselves express thinking, noting that gestures are not only reflections of one's verbalizations but can act as a bridge between action and thoughts. Interestingly, there is some evidence for a rational role of gestures. Cook and Tanenhaus (2009) showed that watching another person's gestures can have an impact on the watcher's subsequent performance. In education settings, Goldin-Meadow and Alibali (2013) suggested that it is clear that the gestures teachers produce can have a positive effect on students’ learning. In sports there is limited research on the relationship between gestures and game outcome. However, there is a body of research which addresses, on a more global level, the effects of body language on performance. More specifically, Greenlees, Buscombe, Thelwell, Holder, and Rimmer (2005) examined the effects of opponents’ clothing and body language (during warm up) on the way they are perceived in table tennis. Their results showed that viewing opponents displaying positive body language were perceived more positively than opponents displaying negative body language. In a more recent study, Furler, Dicks, and Memmert (2012) examined experimentally the effects of signaling dominance (e.g., confidence) and submissiveness (e.g., anxiety) on impression formation and outcome expectation during soccer penalty kicks. Their results indicated that penalty takers who displayed a dominant body language were perceived more positively, by players and goalkeepers, than penalty takers who displayed an submissive body language. Moreover, regarding verbalizations, previous socio-genetic research proposed an internalization/externalization process in which influences and messages from the social context are internalized and interpreted by internal psychological mechanisms and in turn are externalized as self-talk (Lawrence & Valsiner, 2003). Since sport-related research on self-talk has revealed that behaviors of social agents within sport context such as coaches (e.g., Zourbanos, Hatzigeorgiadis, & Theodorakis, 2007) and significant others (e.g., Zourbanos, Theodorakis, & Hatzigeorgiadis, 2006) have an impact on athletes' type of self-talk, we extended these findings further and hypothesized that other sources of social influence (such as overt athletes' verbalizations) within a competitive setting might influence opponents' verbalizations or even opponent game outcome. However, relatively little is known in sport literature about how verbalizations, gestures and game outcome interact and how this can have an impact on the watch's subsequent performance. Hardy, Oliver, and Tod (2009) in their conceptual model of self-talk in sport presented as potential antecedents of self-talk two general categories, namely situational and personal-level factors. In their model, the effects of situational factors on the content of self-talk have been focused on task difficulty, match circumstances, and the influence of coaches' behavior. Furthermore, Hardy et al. (2009) argued, that despite the increasing body of literature of the effects of self-talk on game outcome, research on the antecedents of self-talk is relatively sparse (e.g., Hardy, 2006).

In a series of studies, Van Raalte, Brewer, Rivera, and Pettipas (1994), Van Raalte, Cornelius, Brewer, & Hatten (2000) were the first to examine the effects of match circumstances in tennis as potential antecedents of self-talk. More specifically, Van Raalte et al. (1994) developed the Self-Talk and Gestures Rating Scale (STAGRS), an observational tool which assesses tennis players' use of observable verbalizations and gestures whilst simultaneously recording the score during a competitive match (in the sport literature the term self-talk has prevailed for the description of verbalizations addressed to the self; for review see Theodorakis, Hatzigeorgiadis, & Zourbanos, 2012). Although STAGRS was developed to operationalize self-talk, it captures the broader concept of verbalizations. Van Raalte et al. (1994) using the STAGRS reported that young tennis players’ overt positive verbalizations were not related to better game outcome. However, negative
verbalizations were associated with worse performance and that successful performers used fewer negative verbalizations and gestures than did unsuccessful performers. In another study, Van Raalte et al. (2000) found that adult players' overt negative verbalizations were not associated with losing, suggesting that in some cases negative verbalizations can be motivational and not detrimental to game outcome. As stated above, Van Raalte et al. (1994, 2000) studies were the first to explore the nature of athletes' observable verbalizations and gestures in sport. Nevertheless, Van Raalte et al.'s analyses were descriptive and correlational in nature, and the interplay between gestures, verbalizations, and game outcome was not examined, suggesting that verbalizations have a direct effect solely to the person who uses them. However, in another study Van Raalte, Brewer, Cornelius, and Petipas (2006) examined the effects of self-talk on the others perceptions using videotaped tennis matches. Their results revealed that players shown dubbed positive self-talk were perceived to be better athletes than when those same players were showing playing the same points with dubbed negative self-talk. However, the study was limited based on the fact that perceptions of players self-talk were obtained by a sample of college undergraduates and not by actual tennis players.

**Sequential analysis**

In the cognitive assessment literature, think-aloud, recording of private speech, self-monitoring, self-statement inventories, and other methodologies have been applied to identify individuals' cognitive structures in studies of problem solving and “mind reading” (e.g., Blankstein & Segal, 2003). Recently, Jeong (2012) proposed that sequential analysis would enable researchers to model patterns of cognitive processes observed in training or competition. Sequential analysis has been used in diverse disciplines (Abbott, 1995) within the social sciences (Bakeman & Gottman, 1997). Sequential analytic studies examine discrete behavior occurrences in a contextual level, explore patterns of interplays among individuals and/or events over time (Bakeman & Gottman, 1997). Furthermore, sequential techniques applied to systematic observation data can be used to examine issues like the fashion that behavior is sequenced in time, identify behavioral patterns, and assess contingencies among data collected over time (Bakeman & Gottman, 1997). In the sport domain, Lausic, Tennybaum, Eccles, Jeong, and Johnson (2009) performed a subsequent sequential analysis to examine differences in discourse patterns between winning and losing teams. Calmeiro, Tenenbaum, and Eccles (2010) attempted to interpret complex set of appraisals and coping processes of six male trapshooting athletes during a competitive event with the use of sequential techniques, while Calmeiro and Tennybaum (2011) used content analysis and event sequence analysis to reveal thought processes during a golf putting task of six golfers of diverse experience. Also, Tzioumakis et al. (2012) used sequential analysis to investigate the objective motivational climate patterns initiated by grassroots football coaches. In summary, the results from sport domains using sequential analysis are focused on how to model and study athletes’ appraisal, coping, and thought processes and not on the interplay between thoughts and gestures. Thus, the goals of the present research is to further address and visualize questions about the interplay between young athletes’ verbalizations, gestures, and game outcome on a contextual approach in tennis matches using the STAGRS (observational methodology) and sequential analysis.

In the present study it was anticipated that match circumstances would affect verbalizations, and presumably this would reveal a 'loop' between certain match events and verbalization occurrences. Thus, it was investigated to the degree to which winning a set or game under certain circumstances (e.g., the score is close or break points occurred) appears to be contingent on verbalizations and/or gestures. It was also examined whether there is an effect of one's gestures and verbalizations on the opponent's game outcome. This was deemed appropriate as in previous studies verbalizations had a direct effect solely to the person who used it (Van Raalte et al., 1994; Van Raalte et al., 2000), but as supported by the ecological approach (Gibson, 1979), this relationship depends on circumstances. The methodological approach adopted in this study was inspired by a contextual, non-linear interpretation of human behavior and cognition. Thus, it was hypothesized that verbalizations would not only predict expected effects (e.g., servers’ positive verbalizations would be associated with beneficial outcomes for them and negative outcomes for their opponents) but would also activate reverse effects (e.g., servers’ negative verbalizations would be associated with negative outcomes for them and beneficial outcomes for their opponents) for the people who use them (Cook & Tenenhaus, 2009; Van Raalte et al., 2006). In other words, it was anticipated that a single self-talk instance or gesture might have a simultaneous but diverse effect on the speaker and the listener. For example, we hypothesized that verbalizations would not only predict expected effects (e.g., Servers’ positive verbalizations would associate with beneficial outcomes for them or with negative outcomes for their opponent) but would also activate reverse effects for the person who use it (e.g., Servers’ positive verbalizations would associate with negative outcomes for them or with beneficial outcomes for their opponent). Furthermore, it was examined whether there was a consistent pattern between gestures and verbalizations. In particular, as the literature suggests that gestures may potentially have an effect on thoughts (Beilock & Goldin-Meadow, 2010; Goldin-Meadow & Beilock, 2010) it was hypothesized that gestures recorded in tennis matches would predict players’ verbalizations and vice versa.

**Method**

**Participants**

Participants were 34 (20 males and 14 females) junior tennis players with a mean age of 13.68 (SD = 1.8) and mean competitive experience of 2.9 years (SD = 1.56). The athletes had been practicing with their coach 5.75 h per week (SD = 2.45) and their coach had been working with their athletes between 1 and 5 years (M = 2.81, SD = 1.18). Participants were selected from 3 youth tennis players’ tournaments under the auspices of the National Tennis Association. Two, independent, trained observers equipped with coding sheets were positioned as close as possible to the tennis courts in the stands beside the umpire’s chair, in order to clearly and unobtrusively observe all athletes’ verbal and non-verbal behaviors. Observers were at all times at an appropriate distance from players to prevent any Hawthorne-type or reactivity effects, noise (e.g., cheering from spectators), objects or persons from blocking observers’ clear view of players’ gestures. Also, observers were carefully positioned so that they could hear very clearly players’ verbalizations. None of the observers reported cases where data were missed due to the aforementioned reasons.

**Measures**

**Self-Talk and Gestures Rating Scale (STAGRS)**

The observation instrument includes forms for assessing tennis players’ use of verbalizations and gestures, and simultaneously recording the score during a competitive match. More specifically, athletes’ verbalizations are categorized into 14 distinct instances of verbal and non-verbal self-talk. These discrete categories include:
a) Ball abuse (e.g., a player hitting or throwing the ball away in frustration), b) Complimenting opponent (e.g., praising the opponent on a good play or effort), c) Fist Pump (e.g., the player self-congratulating him/herself by pumping the fist), d) “Oh God” (e.g., body language expressing frustration), e) Hit oneself (e.g., the player intentionally hitting him/herself with a racquet or hand), f) Instructional Self-Talk (e.g., a player advising him/herself on how to perform better), g) Laugh (e.g., player laughing in frustration), h) Motion of stroke (e.g., player practicing the stroke motion), i) Negative Self-talk (e.g., player makes negative comments on his/her performance), j) Opponent abuse (e.g., a player verbally or physically assaults his/her opponent), k) Racquet abuse (e.g., a player hitting or throwing the racquet away in frustration), l) Positive Self-talk (e.g., a player makes positive comments on his/her play), m) Self-talk in general (e.g., unclear or foreign self-talk), and n) Other (e.g., self-talk or gestures that do not fit the above categories). In addition, the coding scheme reports play-by-play scores of the tennis game that include points, faults, aces, games, sets, and service breaks. Coders were also instructed to keep a record of the order (using a sequence of numbers) each event (self-talk, gesture, point, ace, etc.) occurred. Furthermore, composite categories of positive, instructional, and negative verbalizations were formed based on Van Raalte et al.’s (1994) procedures. Coders were also instructed to keep a record of the order each event (using a sequence of numbers for verbalizations, gestures, points, aces, etc.) occurred. After all tennis matches were coded, the data was imported into the Observer XT software for further process and analysis.

Procedure

Firstly, it should be noted that all data collected were from competitive tennis matches and no data was collected during practice or other non-competitive situations. These matches were played during regional qualification rounds leading to the tennis youth finals. The University Ethics Committee approved the study. In addition, all young athletes gave their verbal consent and their parent/guardian gave written consent. The 34 youth players were observed during 17 singles matches, competing against each other.

Initially, in a 6-h workshop organized by the lead researcher the STAGRS manual was thoroughly presented to the trainee coders before the data collection. The instrument as well as the manual was produced through a standardized back translation technique into the coders’ (Greek) language (Brislin, 1986). Two coders that were former tennis players (see more information regarding STAGRS in Van Raalte et al., 1994) and undergraduate sport science students were selected. First, the categories of the instrument were explained in detail. Coders were provided with instructions on how to use the STAGRS which included an introduction about the coding procedures of STAGRS and clarification while viewing previously recorded tennis training sessions and matches. Furthermore, coders viewed and discussed a video file that contained a sequence of exemplary verbalizations instances, which had been correctly recognized and categorized. Further, a collaborative coding session of video clips depicting discrete athlete’s verbalizations and gestures followed, where the researchers introduced coders to the coding procedure, and initiated further discussions, which clarified misunderstandings and identified key elements of the coding process. In the next stage, inter-observer reliability was assessed. An expert rater as well as the two trained observers coded an entire videotaped tennis match. The obtained data were then compared across all raters.

Reliability scores (Cohen’s kappa) were calculated by a built-in application of the behavioral research software Observer XT® (Grieco, Loijens, Zimmerman, & Spink, 2007). Cohen’s kappa was the preferred index for measuring observer agreement, as it takes into consideration chance agreement indicating that the proportion of agreement is above and beyond what would be expected by chance (Cohen, 1960). Observers underwent training until a 0.75 criterion was met. Agreement scores above 0.75 indicate substantial to perfect observer agreement (e.g., Landis & Koch, 1977). Inter-observer reliability was assessed again after a two weeks lapse to ensure consistency among observations. Each observer’s codings were again compared in order for intra-observer reliability to be established at a minimum level of 0.75.

Coder agreement is considered as the “sine qua non” for observational studies (Bakeman, Quera, & Gnisci, 2009). Therefore, observers were calibrated against a standard protocol to obtain acceptable inter- and intra-observer reliability. The coder training protocol was primarily based on the training manual of an established systematic observation instrument with which trained raters assess overt behaviors coaches exhibited in the field, the Coaching Behavior Assessment System (CBAS; Smith, Smoll, & Hunt, 1977) as suggested also by Van Raalte et al. (2004; 2000).

State lag sequential analysis

We used sequential techniques for further data analysis, to provide an insight about verbalizations and gestures as well as any temporal patterns that may have emerged during match conditions. After each game, coding sheets were collected and one of the leading authors imported the data from each coding sheet into the Observer XT 7.0® in order to assess the degree of inter-observer agreement. A substantial to perfect agreement between the two observers was established in all cases ($k > 0.75$). Next, the two raters with the assistance of the lead author identified and resolved the discrepancies between their codings. Finally, a coding sheet containing a single rating of each match was produced, and at a later point in time one of the lead authors imported the data collected into the Observer XT 7.0® for further analysis with sequential analytic techniques.

Sequential analysis was conducted with the Observer XT 7.0®. The Observer XT® calculates the frequency and the probability of transitions between pairs of events within a certain lag. In State Lag sequential analysis, transitions between events either directly follow each other or are separated by a specific number (lag order) of other events. For example, from the first event to the next one means lag order 1, to the second event means lag order 2, the third event lag order 3, and so on (Grieco et al., 2007). In contrast to classical parametric statistics, a basic assumption in sequential analysis of observational data is dependence in the observations. So, in order to detect dependence in the observations we compare observed frequencies with those expected if the observations were independent. Therefore, data dependence is not considered as “problematic” but rather as the main purpose of sequential analytic studies (Bakeman & Gottman, 1997).

Of particular value is the fact that sequential analysis is a probabilistic approach that can better contextualize correlational findings (Chorney, Garcia, Berlin, Bakeman, & Kain, 2010). Sequential approaches can query which participant in an interplay is the leader and which is the follower (i.e., which participant is more likely to cue the other). For example, in interplay between two tennis players, does positive verbalizations of the server increase the probability to prompt negative verbalizations for the receiver, or does positive verbalizations of the server increase the probability to prompt positive verbalizations for the receiver?

Furthermore, sequential analysis may provide answers to more complex questions like: In a tennis game, does the use of positive verbalizations from the player that serves the ball increase the probability to result to a winning game for him/her when one (lag
2), two (lag 3), or more random intervening match event/s? (e.g., for lag 3 “Server Positive verbalizations → (random event) → (random event) → Winning Game for Server”). Extending the previous sequence of events in a tennis match, when we observe specific sequential patterns of events as the above, which are statistically significant, there is a contingency between the observed events “Server Positive verbalizations” and “Winning Game for Server” (for lag 3). In simple words, we can conclude that when server uses positive self-talk then there is an increased possibility to win a game. The Observer XT software provides the sequential analysis results as it calculates significance for every possible pairing if events, either they directly follow each other (lag 1) or are separated by one (lag 2), two (lag 3) three (lag 4) or more events (Grieco et al., 2007). For the purposes of the present study, the authors decided to analyze the data in a lag 2 and lag 3 order and not in a lag 1 since it is common for a few events to intervene between the occurrence of verbalizations and the winning point of the game. This is also reinforced by the way the data set was imported by the software, for example, the coding for “winning the game” (which in our study was used as an outcome indicator) is always preceded by a “point won” coding, making it therefore impossible to detect any other event sequence for lag 1 other than “Server/Receiver Point → Winning Game for Server/Receiver”, except for our examination of the relationship between gestures and verbalizations, which we have included in a lag 1 analysis.

Also, Bakeman and Gottman (1997) proposed for large chains of events the investigation of sequences comprising more than two events was required to gain further insight into the wealth of information produced. So, if data were analyzed in a lag 1 order, we would not find associations between verbalizations and games won by the players but associations between verbalizations and other instances of verbalizations, gestures, faults, points, double faults, etc. Lag 1 would provide us with more meaningful results in case we examined the immediate association between verbalizations, gestures, and any points each player wins during the game. This is an approach we used in a previous stage of the data analysis, but winning a game probably is more performance-related than winning a point.

We also decided not to present results in a lag 4, lag 5, or lag 6 order, as during many games of our sample, we recorded no more than three events after the occurrence of verbalizations, since youth athletes can not usually sustain high levels of competition, so inevitably a large part of the sample would be excluded from the analysis.4 The statistical significance of interplay patterns is expressed by transition probability in a 0 to 1 scale (p < .05, z < 1.96). Transitional probability, which is a type of conditional probability, is distinguished from other forms of conditional probabilities as the target and the criterion event occur at different times (Bakeman & Gottman, 1997). In our case, transition probability is the number of transitions for a particular combination of criterion event and target event divided by the total number of transitions from that criterion event (Grieco et al., 2007). Furthermore, z scores (adjusted residuals) were calculated according to Bakeman and Gottman’s (1997) suggestions, to examine which transitional probability scores deviated significantly from their expected values. It should also be noted that only behavioral categories that had significant values (p < .05, z < 1.96) higher than expected probability were reported, due to the magnitude of the data set.

Furthermore, since our observations are derived from different subjects, we adopted Bakeman and Gottman’s (1997) suggestions and avoided to pool data over subjects. We therefore conducted separate sequential analyses for each of the 17 matches, and computed a mean transitional probability value for each verbalization and gesture category. This is also the reason why transitional probability values reported in the manuscript are not equal to 1.

Also, we should note that we analyzed the data on two levels; firstly from the angle of the serving player and secondly from the receiver’s standpoint. Apart from examining whether verbalizations affected game outcome, we also examined, for example, whether verbalizations and gestures of the serving player correlated with the verbalizations and gestures of the receiver, or whether server’s verbalizations correlated with the server’s gestures and vice versa. In other words, we coded both server’s and receiver’s match events, verbalizations occurrences, verbalizations, and gestures in a sequential order, as these events unfold over time, and examined whether the elicited sequence of events reflect significant “patterns” of interplays. For this reason, verbalizations and gestures occurrences as well as match events were distinguished between the server and the receiver within each match.

Results

Descriptive statistics provide an overview of the verbalizations and gestures exhibited by the participating athletes (see Table 1). We also calculated descriptive data of the appearance of the composite measures of positive, instructional, and negative verbalizations. The composite measures were formed by calculating the scores of the respective STAGRS categories. Descriptive statistics are also displayed for servers and receivers individually (Table 1).

Sequential analysis lag 2

Fig. 1 shows the results from state lag sequential analysis lag 2. The figures are graphic representations of match events. Within the figures, nodes connect events via unidirectional arrows that indicate the probability of transition from a criterion to a target event. The arrow thickness indicates the strength of the transitional probability, while frequencies of certain pair of events are indicated by the figures in brackets. Non-significant relationships between pair of events are omitted. Although negative verbalizations related to 10 winning games for the players that used it, they also related to the winning of 14 games for their opponents. The winning of 10 games for the players that used it, are aggregation of (“server negative verbalizations → random event → winning game for server”) plus (“receiver negative verbalizations → random event → winning game for receiver”), whilst the winning of 14 games for their opponents are aggregation of (“server negative verbalizations → random event → winning game for receiver”) plus (“receiver negative verbalizations → random event → winning game for server”). More specifically, according to Fig. 1, server’s negative verbalizations (lag 2) related to a winning game for the server eight times. On the other hand, also according to Fig. 1, the server’s negative verbalizations (lag 2) related to a winning game for the receiver nine times within all 204 games in 17 matches (p < .05, z < 1.96). Furthermore, the receiver’s negative verbalizations related to a winning game for the receiver (lag 2) twice, whilst the receiver’s negative verbalizations related to a winning game for the server (lag 2) five times. In other words, when a player uses negative verbalizations, and these are followed by one random event, there is a greater probability of winning a game for the opponent. In addition, according to Fig. 1, the server’s “Oh God” cry of frustration related to a winning game for the server (lag 2) three times, and on the other hand, the server’s “Oh God” frustrated response related to the winning of nine games for their

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4 The results from lag +1, lag +4, lag +5 or lag +6 are available upon request, from the first author.
opponent (lag 2). Thus, sequential analysis informs us that when “Oh God” frustrations are expressed by a youth tennis player in our sample and it is followed by one random match event, it is significantly more likely to relate to a winning game for their opponent rather than for the player that used it. In a similar vein, three winning games relate to players that used positive verbalizations and none for their opponents. This means that positive verbalizations were slightly related to winning games, and were not related to losing games. Furthermore, the motion of the stroke related to winning one game for the player that used it but also related to winning four games for their opponents. The above results provide weak evidence for a relationship between the motion of a stroke and the game outcome for the player that uses it. Transition probabilities in all the above cases were high (0.77–1) except for positive verbalizations (0.33). We should also note that the findings are presented and interpreted through the lens of our initial hypothesis that there is a probability a single self-talk instance or gesture may have a simultaneous but diverse effect on the speaker and the listener. Although indications are promising results should be viewed with caution (see limitations section). In summary, negative verbalizations for either the server or the receiver, as expected, decreased the probability of winning a game.

Sequential analysis lag 3

Similarly to lag 2 analysis, negative verbalizations for either the server or the receiver predict a decreased probability of winning a game. Although negative verbalizations related to winning three games for the players that used them, they also resulted in winning 18 games for their opponents. These winning games were aggregated similarly to lag 2. More specifically, server’s negative verbalizations resulted in winning nine games for the receiver (lag 3). On the other hand, the server’s negative verbalizations did not result in winning any games for the server (lag 3) within all 204 games in 17 matches. Furthermore, the receiver’s negative verbalizations resulted in winning nine games for the receiver (lag 3), while the receiver’s negative verbalizations resulted in winning nine games for the server (lag 3). In other words, players that use negative verbalizations, and when these are followed by two random events, they appear to result to a negative result for them. Moreover, in line with lag 2 results, the server’s “Oh God” frustration related to winning four games for the receiver (lag 3), while the server’s “Oh God” frustration did not relate to winning any games for the server (lag 3). On the other hand, the receiver’s “Oh God” frustration related to winning three games for the server (lag 3), and the receiver’s “Oh God” frustration also did not relate to winning any games for the receiver (lag 3). In general, the results suggest that the use of frustrated terms such as “Oh God” by youth tennis athletes seems to have only negative effects on their game outcome. In general, as lag 3 analysis showed, gestures seem to

Table 1

Descriptive statistics for STAGRS categories for 204 games in 17 matches, for servers and receivers.

<table>
<thead>
<tr>
<th>STAGRS Categories</th>
<th>Freq</th>
<th>Mean per game</th>
<th>Mean per match</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opponent abuse</td>
<td>4</td>
<td>0.02</td>
<td>0.24</td>
</tr>
<tr>
<td>Positive self-talk</td>
<td>105</td>
<td>0.51</td>
<td>6.17</td>
</tr>
<tr>
<td>Fist pump</td>
<td>87</td>
<td>0.43</td>
<td>5.11</td>
</tr>
<tr>
<td>Motion stroke</td>
<td>96</td>
<td>0.47</td>
<td>5.64</td>
</tr>
<tr>
<td>Negative self-talk</td>
<td>238</td>
<td>1.17</td>
<td>14</td>
</tr>
<tr>
<td>Instructional ST</td>
<td>31</td>
<td>0.15</td>
<td>1.82</td>
</tr>
<tr>
<td>“Oh God!” frustration</td>
<td>103</td>
<td>0.50</td>
<td>6.05</td>
</tr>
<tr>
<td>Complimenting opponent</td>
<td>25</td>
<td>0.12</td>
<td>1.47</td>
</tr>
<tr>
<td>Ball abuse</td>
<td>14</td>
<td>0.07</td>
<td>0.82</td>
</tr>
<tr>
<td>General (unclear) self-talk</td>
<td>22</td>
<td>0.11</td>
<td>1.29</td>
</tr>
<tr>
<td>Laugh</td>
<td>16</td>
<td>0.08</td>
<td>0.94</td>
</tr>
<tr>
<td>Hit oneself</td>
<td>2</td>
<td>0.009</td>
<td>0.11</td>
</tr>
<tr>
<td>Racquet abuse</td>
<td>29</td>
<td>0.14</td>
<td>1.70</td>
</tr>
<tr>
<td>Points</td>
<td>1049</td>
<td>5.13</td>
<td>61.70</td>
</tr>
<tr>
<td>Games</td>
<td>204</td>
<td>–</td>
<td>12</td>
</tr>
<tr>
<td>Matches</td>
<td>17</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Fig. 1. Observable verbalizations, transitional probability rates and winning games (in parentheses) for 204 Games in 17 Matches (Lag Order +2). p < .05, z < 1.96. Note: S = Server; R = Receiver; Server Game = Games won by the Server; Receiver Game = Games won by the Receiver; Positive = Positive verbalizations; Negative = Negative verbalizations; “Oh God” = “Oh God!” Frustration; Fist Pump = Fist Pump Gesture; Motion Stroke = Motion Stroke Gesture; General verbalizations = Verbalizations in general; Point = Points Won; Fault = Serve Faults.
have a limited effect on game outcome. Transition probabilities in all the above cases were moderate to high (0.63–1).

As the results indicate, there was a clear pattern of expected verbalization functions in most cases. For instance, according to previous research findings, an increased probability of beneficial effects of positive verbalizations on athletes’ game outcome would be characterized as expected verbalizations function. On the other hand, an increased probability of negative effects following positive verbalizations on an athletes’ game outcome would be a reverse verbalizations function. In the same vein, an increased probability of losing a game for the athletes that used the “fist pump” gesture would also be a reverse gesture effect. Therefore, all expected, and on the other hand, all reverse verbalizations and gestures functions were aggregated. More specifically, 37 winning games of expected verbalizations functions were reported for lag 2 and 34 winning games for lag 3. However, there was a significant number of occasions that verbalizations had reverse outcomes but of a lower magnitude with winning 16 games reported for unexpected verbalizations function for lag 2 and winning 21 games for lag 3.

A circumstances → verbalizations and/or gestures → game outcome approach

We also considered analyzing data from the aforementioned perspective, that is, we investigated the degree to which winning a set or game under certain circumstances (e.g., the score is close or break points occurred) appears to be contingent on verbalizations and/or gestures. We first went through data to search for situations within certain sets where the game score was close (e.g., 5-5, 5-6, 6-6, etc.) but no such situations were coded. We then proceeded to search for situations within games and specifically games in which break points occurred. We found 34 games where break points occurred and we analyzed these games in lag 2 and lag 3. As Fig. 4 shows for lag 2 analysis, in 12 games (35.2% of the games in which break points occurred) the use of verbalizations seems to increase the probability of winning a game from either the server or the receiver. Specifically, negative verbalizations in general for both the server and the receiver (negative verbalizations and frustrated “Oh God” comments) had a greater impact on the game outcome for the youth athletes in games where break points occurred, as in 11 of these situations there was an increased probability of negative game outcome effects for the athletes that used it (in 11 of the 12 games coded for lag 2). Positive verbalizations seem to have a very limited impact on game outcome (one game) and gestures under these circumstances do not seem to have an effect at all on game outcome. Furthermore, analyzing the data in lag 3 sequential analysis (Fig. 5), a very similar pattern was observed as we found that in 14 games (41.1% of the games in which break points occurred) there were indications that negative verbalizations

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5 The figure depicting results from lag 3 analysis was omitted for reasons of space and is available upon request from the first author.
increased the probability for the players that used it to lose a game (e.g., receiver negative verbalizations → random event → 4 winning games for server) and “server negative verbalizations → random event → (random event) → 5 winning games for receiver”). Gestures seem to have a very weak effect on game outcome (one game) and positive verbalizations do not seem to have any impact on game outcome at all. In sum, mostly verbalizations and to a lesser degree gestures, in games that break points occurred, seem to increase the probability of affecting the result in the 18.1% for lag 2 and 21.5% for lag 3 on the overall number of games won (34). Additionally, according to state lag sequential analysis of the verbalizations exhibited by the athletes, verbalizations explains 66 (32.35%) and 65 (31.9%) of the winning games for lag 2 and lag 3 respectively. Games, faults, double faults, and aces account for the remaining 138 (67.65%) and 139 (68.1%) games won respectively for lag 2 and lag 3.

Gestures and self-talk

According to the results, the hypotheses of the link between gestures and verbalizations were supported. For lag 1, fist pumps seems to have an immediate effect on positive verbalizations (0.63; “fist pump → positive verbalizations”, see Fig. 2). In addition, a fist pump had a weaker but significant immediate effect on the motion of the stroke (0.38; “fist pump → motion of stroke”). However, positive verbalizations also had an immediate effect on fist pumps (0.57; “positive verbalizations → fist pump”) as well as on the motion of the stroke (0.38; “positive verbalizations → motion of the stroke”). “Oh God” frustrated responses also had an immediate significant effect on negative verbalizations (0.44; “Oh God” → negative verbalizations). All of the above values, albeit weaker than the ones reported between instances of verbalizations, are significant (p < .05, 2 < 1.96). No other significant relationships between gestures and verbalizations emerged (see Fig. 2). Whereas, for lag 2 (Fig. 3) it seems that, the use of positive verbalizations increased significantly the probability for subsequent use of the motion of the stroke (0.75; “positive verbalizations → random event → motion of stroke”), but fist pumps seems to have a weak although significant relationship with increasing the probability to use positive verbalizations (0.33; “fist pump → random event → positive verbalizations”), and the motion of the stroke (0.44), while the motion of the stroke has an equally weak but significant relationship with positive verbalizations (0.33; “motion of stroke → random event → positive verbalizations”). Also, it

seems that negative verbalizations increases significantly the probability for a “loop”, that is when athletes use negative verbalizations they will probably use negative self-talk (0.83) again after an intervening event. Moreover, negative verbalizations increased significantly (0.68) the probability of the use of another form of negative verbalization, such as “Oh God” frustrated comments after an intervening event.6

Discussion

The results of this study were to investigate patterns of interplay among verbalizations, gestures, and scores of junior tennis matches. Gestures and verbalization sequences of players were analyzed to identify characteristic patterns of verbalization gestures that may discriminate between winning and losing a game. This is the first examination of the combined effects of gestures and verbalizations and game outcome using a sequential analysis. The data were obtained in a setting that is representative of the context towards which we want to generalize the study findings (Araújo, Davids, & Passos, 2007), that is, in a competitive tennis match context. Sport competition is a context in which there are expressions of different gestures and verbalizations in different moments under different situations. The current findings support Van Raalte et al.’s (1994) results that young athletes’ negative verbalizations for either the server or the receiver decreased the probability of winning a game. Furthermore, links between gestures and verbalizations were recorded providing rich information for further research. Furthermore, as descriptive data from the present study as well as from previous studies revealed, although STAGR has been used to players from diverse linguistic backgrounds, the pattern of these results were quite similar.

Verbalizations, gestures and game outcome

Results are consistent with previous findings from descriptive studies (Van Raalte et al., 1994; Van Raalte et al., 2000) which found that in approximately 30% of the points played, some form of verbalizations or gestures were recorded. Furthermore, also in line with similar studies, it was found that young athletes used more negative verbalizations than positive or instructional verbalizations during their matches. More specifically, negative verbalizations were the most frequently (406) exhibited form of overt verbalizations, following positive (217), and instructional verbalizations (127). Furthermore, previous results showed that winners used fewer negative verbalizations and gestures than did losers (Van Raalte et al., 1994). However, winners and losers did not differ in terms of positive verbalizations. Our results extended previous findings by showing that verbalizations either related to expected outcomes for the player that used it or to expected outcomes for their opponents. For example, positive verbalizations for the server was related to successful game outcome for the server, and in the same vein, negative verbalizations for the server was related to unsuccessful game outcome for the server or to successful game outcome for the receiver. This is interesting since it shows how the behavior of both the receiver and the server are coupled (Carvalho et al., 2013), as predicted by the ecological approach of the study. Furthermore, from a total of 204 games played, positive verbalizations were related to winning 37 games for lag 2 and 34 games for lag 3. However, there was a significant number of occasions that verbalizations had reverse outcomes but of a lower magnitude,

Fig. 5. Observable verbalizations, transitional probability rates and winning games (in parentheses) for 34 Games that break-points occurred (Lag Order +3; p < .05, 2 < 1.96. Note: S = Server; R = Receiver; Server Game = Games won by the Server; Receiver Game = Games won by the Receiver; Positive = Positive ST; Negative = Negative ST; ‘Oh God’ = “Oh God!” Frustration; Fist Pump = Fist Pump Gesture.

6 Results and figure from lag 3 analysis were omitted for reasons of space, as they were similar to lag1 and lag 2. These results and figure are available upon request from the first author.
negative verbalizations related to winning 16 games for lag 2 and in 21 games for lag 3. It is possible that sometimes negative verbalizations are not so detrimental to game outcome, and instead they have a motivational role for athletes (e.g., Van Raalte et al., 2000). From an applied perspective this means that negative verbalization sometimes may operate motivationally not only for adult players but also for younger players (e.g., Van Raalte et al., 2000), in the form of thoughts related to the psyching-up process. If we consider that athletes may get used to such verbalization and eventually learn not to relate them, these negative verbalizations may be to their benefit. These reverse effects show a linear relationship of how verbalization and game outcome are related, however, it is the contextualized dynamics of this relationship that matters (Carvalho et al., 2013). In Carvalho et al.’s (2013) study verbalizations had an effect not only on the speaker but also on the listener. These results suggest that athletes’ verbalizations showed a social context effect (e.g., Reed, 1991). Indeed verbalizations are means to share knowledge (Reed, 1991), but also in some cases watching another person’s gestures can have an influence on the watcher’s subsequent outcome (Cook & Tanenhaus, 2009). Regarding gestures and game outcome the results showed that a “first pump” related to winning two games for the players that used it and in winning one game for their opponents. In a similar vein, winning four games of related to the fact that used the instructional gestures such as “motion of stroke” and only winning one game for the opponent. These results, although they provide limited support for a positive gestures outcome relationship, are in accordance with Beilock and Goldin-Meadow’s (2010) study who argued that one’s own gestures can have an impact on one’s subsequent outcome.

Different patterns of relationships between verbalizations and gestures emerged. The psych-up gesture such as a “first pump” seemed to have an immediate (lag 1) association with positive verbalizations, but also on instructional gestures such as “motion of stroke”. However, positive verbalizations were related to “first pump”, as well as on “motion stroke”. On the other hand, an emotional gesture of frustration such as “Oh God” also was related to negative verbalizations. Another finding was that in some situations negative verbalizations predicted the motion of the stroke. These results highlight that gestures and thoughts may play a part in the same process of sharing knowledge about their own outcome during the match (Araújo et al., 2009). Beilock and Goldin-Meadow (2010) argued that gestures force people to think with their hands. In sports, this is the first study to highlight the influence of gestures on verbalizations. Although the results suggest that verbalizations and gestures do not have a very strong relationship on game play, this might be indicative of the complexity of contextual factors and the extent to which a persons’ interaction with diverse environments and situations influences human behavior.

How circumstances, verbalizations and gestures relate to game outcome

In our attempt to examine to what degree verbalizations and gestures were related to game outcome under different circumstances, we found that verbalizations had a greater impact on athletes’ game outcome than gestures. In certain situations where pressure and anxiety for the outcome was probably raised, as the score was close, negative verbalizations were related to losing a game. For lag 2, (fig. 4) it is noteworthy that negative verbalizations increased (moderately to strongly) the probability for the player that used it to lose the game. Moreover, the negative effects of negative verbalizations on game outcome were confirmed in all negative verbalizations occurrences. In addition, positive verbalizations seem to have a very limited association with game outcome, while gestures were not related to game outcome at all. The same pattern was also detected for lag 3 (Fig. 5), as the occurrence of negative verbalizations decreased the probability for the athletes to lose the game. Van Raalte et al. (1994) reported similar results showing that young tennis players’ overt positive verbalizations were not related to better game outcome. However, negative verbalizations were associated with worse game outcome and that successful performers used fewer negative verbalizations and gestures than did unsuccessful performers. Once more, gestures seem to have very limited association with game outcome.

Given the nature of the current study, there are a number of limitations that further research should address. First, although we have considerable indications of increased possibility that verbalizations and gestures were related to performance indicators (game outcome), results should be interpreted with caution as myriad of other factors affecting this relationship, may well exist. Second, the findings are limited to youth athletes at present, therefore the investigation was limited to youth athletes to avoid the threat of age and experience confounds. Adopting the same methodology but using adult players would strengthen the results of the present study and would provide more insight on the verbalizations–gestures relationships. Future research should also examine the interplay between young athletes’ verbalizations, gestures, and game outcome in doubles play. Building upon previous research that explored the effect of coaches’ and athletes’ verbalization (e.g., Cook & Tanenhaus, 2009; Zourbanos, Hatziegeorgiadis, Tsiakaras, Chroni, & Theodorakis, 2010), future research may consider examining coaches’ and parents’ verbalizations and gestures and how they influence athletes’ game outcome via sequential analyses.

Furthermore, given the fact that the present study is one of the first attempts to translate and apply STAGRS on non-English speaking population, it seems that it would be of particular scientific interest for researchers to further conduct studies examining the functions of self-talk in diverse populations and cultures. The results of the present study provide a preliminary cross-cultural validation of STAGRS and offer a quite promising field for sport researchers to explore. Goldin-Meadow and Beilock (2010) suggested that gestures make thoughts concrete, bringing movement to the activity that’s going on in your mind. Based on the correlational results from the current study and the interplay between gestures and verbalizations it would be interesting to examine the effects of gestures or the combined effect of verbalizations and gestures on task performance not only in sports but also outside of the sports context (Hardy & Zourbanos, in press). Future experimental manipulations could involve training athletes to deliberately use positive gestures such as “motion of stroke” or a “first pump” or iconic gestures such as the use of a smile as part of their coping skills verbalizations or game strategy. This would be particularly interesting when examining the influence of one person/athlete on another. Athletes can use gestures to regulate their thoughts, providing another route to themselves to change their thought patterns. Furthermore, analyzing and interpreting behavioral manifestations in a sequential manner might enable us to identify reliable “behavioral signatures” that is, distinctive behavioral-situation patterns (e.g., Mischel & Shoda, 2010) that in turn would lead us to the identification of situational variables that may have an effect on cognitions, verbalizations, gestures, and eventually behaviors across diverse settings (e.g., Smith, Shoda, Cumming, & Smoll, 2009). From an applied perspective as self-talk strategies have proven effective in enhancing sport performance (Hatziegeorgiadis, Zourbanos, Galanis, & Theodorakis, 2011), the findings can help identify patterns of verbalizations and gestures which could be used for developing such self-talk routines. Streeck (2009) argued that hands are organs of actions, perception, and knowledge acquisition. ‘Motion of stroke’, a ‘first pump’, or iconic gestures, seem to elicit helpful behavior and have the potential to
change athletes’ cognitions. The study provides valuable preliminary evidence and encourages further research regarding the role of verbalizations and gestures on game outcome, behavior, and human interaction.

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References