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Deception in Tennis: An Ecological Dynamics Perspective

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ABSTRACT

Deception is ubiquitous and potent in high-level tennis. While this skill is applauded by players and fans, it appears to have garnered limited consideration from coaches and researchers. This paper examines kinematic deception in tennis singles play from an ecological dynamics (ED) perspective, offering definitions, a descriptive taxonomy, and training recommendations for both performing and defending against deception. An understanding of deception would be incomplete without an understanding of its counterpart anticipation — each skill emerging from the players' attempt to gain an advantage in the point/match. ED concepts and frameworks to aid in the training of both anticipation and deception are offered — representative training design (RT), periodization of skill training, (anti)fragility, and action capacity training. Finally, practical activities to develop and defend against deception are provided.

Key words: Kinematic deception, anticipation, ecological dynamics, skill acquisition

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INTRODUCTION

Deception is an inherently biological phenomenon — octopuses, chameleons, and countless other animals employ it for survival. Twenty-five hundred years ago, Sun Tzu (~500 BCE/2014) observed that "all warfare is based on deception." Sport is no different.

Take a look at any highlight reel from 2025 and compare the quality of points on display with that of decades past. Today's tennis professionals exhibit greater movement complexity than ever before. Often, their amazing shots are executed with intentionally misleading cues, or they delay revealing pertinent information to maximize their shot's impact. These unexpected and effective actions end up on internet highlight reels, but also occur more subtly within the point to create an advantage. While these moments feel more conspicuous now, elite athletes have always tried to reduce the impact and uncertainty concerning their opponent's actions, and increase the impact and uncertainty concerning their own actions. The interplay between anticipation and deception is a foundational feature of high-level dyadic competition in sports with high spatio-temporal demands.

Most research on these interaction skills has focused on anticipation, with comparatively little attention given to deception. Moreover, studies have tended to examine perceptual-cognitive and kinematic aspects in isolation (Panten et al., 2019). This is a meaningful limitation. Farrow and Abernethy (2003) demonstrated that intermediate players' anticipatory abilities were magnified relative to novices under more representative conditions — but not when only a verbal response was required. This is consistent with a broader literature showing that experiments decoupling perception and action diminish the expert advantage (Buszard, 2022). There is also a neuro-anatomical basis for this phenomena. A verbal response engages only the ventral vision-for-perception system, while a movement-based response also recruits the dorsal vision-for-action system (van der Kamp et al., 2008). On a tennis court, deception emerges in response to an opponent's actions across multiple timescales — far more complex than detecting a misleading cue in isolation. A player may establish a pattern of directing forehand approach shots to the opponent's backhand, only to replicate that preparation before redirecting to the forehand side at the last moment. This research tendency to prioritize experimental control over representativeness has been informative but has left our understanding of these interactions incomplete (Ramsey et al., 2022).

Understanding these complex interactions requires a framework for motor control. Two major approaches exist: the cognitivist (C) approach, which has long dominated, and ecological dynamics (ED), which offers an alternative account. For a detailed philosophical comparison, Wilson et al. (2024) is instructive. Araújo et al. (2025) make a compelling case for ED as the dominant paradigm in sport performance analysis. Rob Gray (2021a) examines the two motor-control approaches in baseball hitting, and Carrilho et al. (2025) critique predictive control (rooted in C), before utilizing prospective control (rooted in ED) to explain how soccer defenders anticipate and coordinate to prevent attackers from scoring. This paper adopts an ED lens for its more comprehensive and parsimonious account of motor control.

The purpose of this paper is to define and distinguish different kinematic manifestations of deception, and to explore how players can both perform and defend against it. Contextual

factors are inseparable in the execution of the deception skill, but the focus here is on kinematics within singles play, during the point, and within the rules/spirit of the game. Implications for training deception and practical activities are also offered.

DEFINING DECEPTION

A successful deceptive action can be defined as one that coerces an opponent into a movement pattern that is subsequently exploited (Woods et al., 2020). This skill is associated with advanced players because of the increased motor demand — one must supplement veridical action with deceptive actions. Deception is both common and effective at the professional level. Dimic et al. (2023) used frame-by-frame video analysis of the 2019 Wimbledon final to identify incongruencies between shot preparation and post-contact ball trajectory. Deception was employed on 28% of baseline shots, and deceptive shots produced advantageous point dynamics at a higher rate (56%) than non-deceptive shots (38%). Incorrect anticipatory responses were far more frequent on deceptive shots (85%) than veridical ones (23%). These outcomes are consistent with comparable studies in basketball, rugby, netball, and soccer (Güldenpenning et al., 2023).

While exploitation is deception's most obvious purpose, players also use deception to elicit information. We don't just perceive to act — we also act to perceive. From an ED perspective, deception is one aspect of each player's attempt to develop "maximum grip" (gain an advantage) on the interaction by exploiting information across multiple timescales (Ramsey et al., 2022). Present performance is shaped by a player's previous encounters with the performance environment (retrospectively — skill, experience, memories) and oriented toward the future through the perception of affordances (Araújo et al., 2025).

Affordances are the directly perceived opportunities for action relative to a player's capabilities (Araújo et al., 2025). In tennis, affordances evolve relationally — each player's actions shape the other's. Within any given affordance, the player perceives both specifying and non-specifying information. Specifying information consists of ambient energy arrays that lawfully guide action without requiring mental prediction or elaboration (Araújo et al., 2025; Gray, 2021a). Experts are better attuned to specifying information. Rosker and Majcen Rosker (2021) showed that international players adapted their visual search strategy during serve return more effectively than national players, yielding more successful returns. In tennis, specifying information for ball interception becomes increasingly informative as the opponent approaches contact (guiding the player's general positioning for their next shot), and is unambiguously instructive after it (Müller & Abernethy, 2012). Research suggests professional players respond to ball flight information with ~100% accuracy as early as 160ms after the opponent's contact (Triolet et al., 2013). A player's deceptive behavior can impair the opponent's attunement to specifying information, undermining their grip on the point.

Successful anticipation and deception rely on both contextual and kinematic information. Contextual information "reflects the circumstances preceding and surrounding the interaction" (Ramsey et al., 2022; p.3). This could be linked to a particular opponent's preferences on how to act depending on the score, or in a particular game situation. Kinematic information evolves during a given interaction i.e., the current movements of the opponent and/or the flight of the ball (Ramsey et al., 2022). In the ED tradition, it is postulated that anticipation and deception occur prospectively — as opposed to predictively (rooted in C) — through the player's attempt to realize affordances (Araújo et al., 2025, Carrilho et al., 2025; Gray, 2021a).

Anticipation and deception are both employed to gain an advantage, but they operate inversely. Kinematically, anticipation can be understood as one aspect of a system maintaining a negative phase relationship with another — as when a player moves in the direction of a shot before the opponent makes contact (Stepp & Turvey, 2010). Kinematic deception, conversely, can be defined as one aspect of a system causing another to lose that negative phase relationship, or to incur a positive one (Gray, 2021b; Ontañón-García et al., 2021). Put simply: anticipation is an attempt to improve one's own affordances, while deception is an attempt to undermine the opponent's.

DESCRIBING DECEPTION

In this section, vocabulary, perspectives, and parameters will be offered to help discuss deception in the context of a point.

Deception in tennis can be organized into three subcategories. Deceit involves offering a functional but misleading affordance (Panten et al., 2019; Ramsey et al., 2022). Disguise involves concealing specifying information until as late as possible, limiting the opponent's field of affordances (Panten et al., 2019; Ramsey et al., 2022). Finally, "distraction refers to actions that (re-)direct the attention of opponents from task-relevant, specifying information toward less relevant, non-specifying information" (Zheng et al., 2023; p.2). These subcategories can operate alone or in combination, and all function to impair the opponent's perception-action coupling.

As previously mentioned, deception emerges and evolves relationally. Tennis' rules result in varying degrees of influence competitors can have on the interaction. Active influence of the situation is conferred on the player about to strike the ball, with the opponent preparing to receive the ball having less agency (contra-active influence) over the situation (Panten et al., 2019). While most research has focused on the active deceiver, deception occurs in both roles. Contra-active deception takes kinematic form primarily through (1) gestures, and (2) presence (posture and positioning) (Panten et al., 2019).

Deception can also co-occur with anticipation. Often, this collaboration with anticipation is the case in contra-active deception (see figure 2.). Active deception also occurs with anticipation. For instance, a player who knows their opponent likes to offer open court before anticipating to cover it can prepare as if going cross-court, then play behind the opponent instead. Finally, deceptive and veridical information can be combined either sequentially — where the deceptive act terminates before the genuine intention is revealed — or simultaneously, where the two merge within a single action (Panten et al., 2019).

DOING DECEPTION

Active deception places supplementary motor demands on the player toward three distinct ends (Panten et al., 2019; Ramsey et al., 2022; Zheng et al., 2023). Completion deception involves a full termination of the misleading

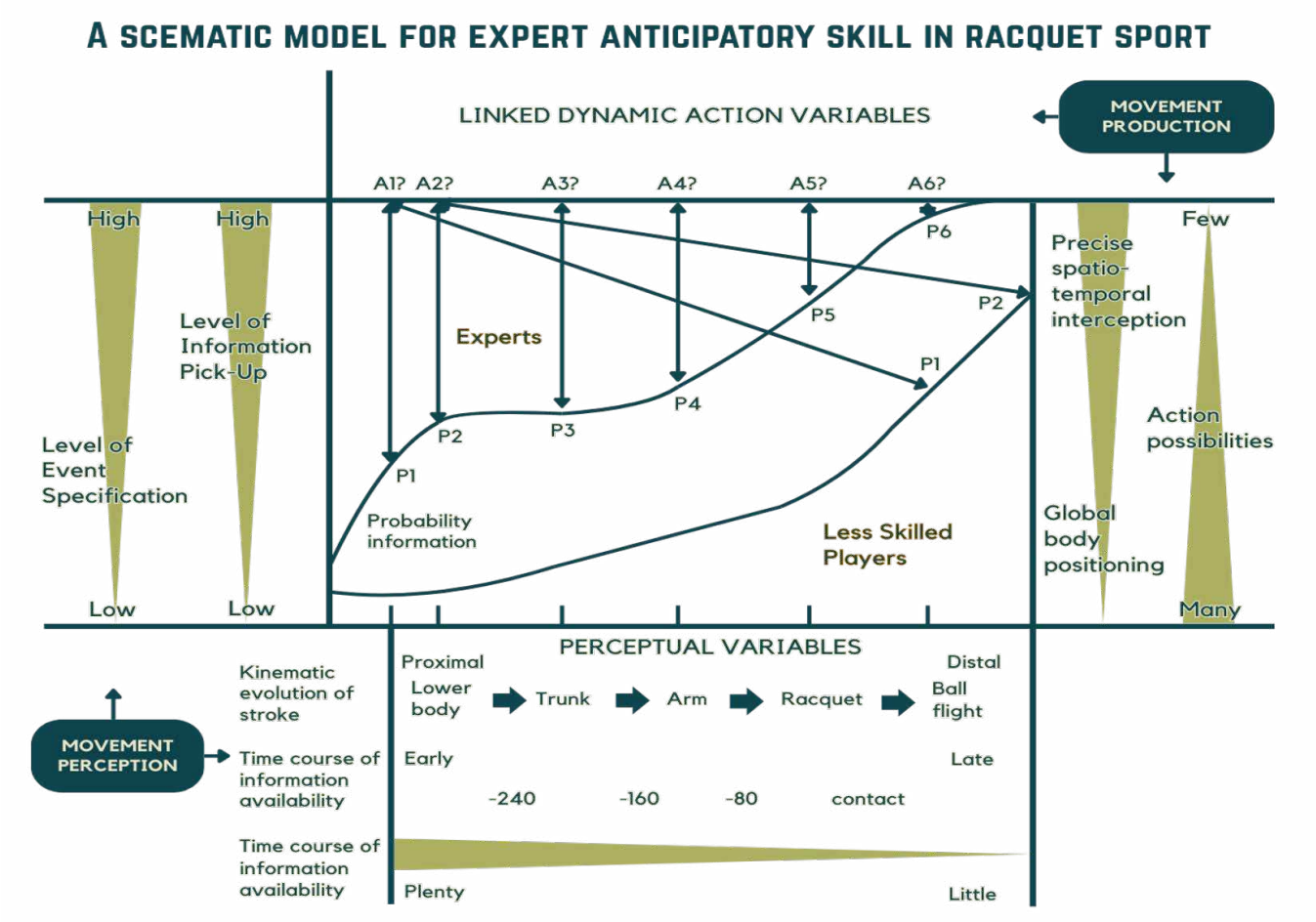


Figure 1. *A schematic model for expert anticipatory skill using a racquet sport as an example. Perceptual variables (P) refer to the key visual information sources available during the proximal-to-distal (early-to-late) evolution of kinematics in an opponent's movement pattern, expressed in regard to the time available for a performer to prepare and respond. Action variables (A) refer to the movement execution phases that need to be coupled to perceptual information to allow successful attainment of the skill goal (i.e., to strike a ball efficiently). The link between perceptual information and action variables may also serve to inhibit action depending on the skill goal. For interception, the model shows that as perceptual information evolves over time, there is an increase in the informational cues that can be used for attainment of the skill goal. Experts (shown in the top trace) are capable of acquiring perceptual information before (P) and during the course of the opposing player's precontact movement pattern (P,-P.), with this early information used to guide global (or gross) positioning of the body. Thereafter, later information from object flight (P) is used to guide and fine-tune interception. Together, acquisition of advance and object flight information guides a progressive reduction in the degrees of freedom of the action system to attain the skill goal. In comparison, less-skilled players (shown in the lower trace) acquire later evolving informative cues (P, and P,) to achieve levels of body positioning and interception comparable to that of experts. With little time remaining to respond, this inevitably results in poorer task performance.*

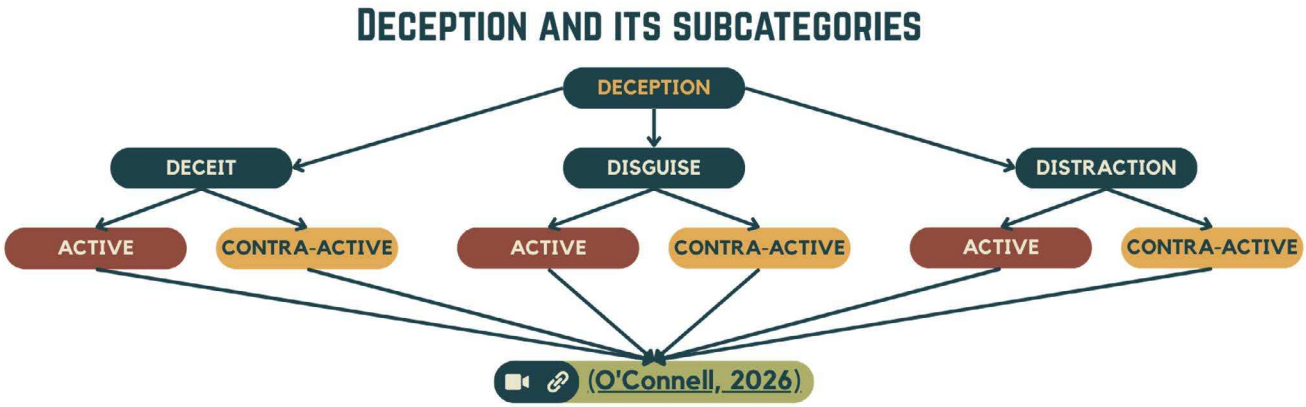
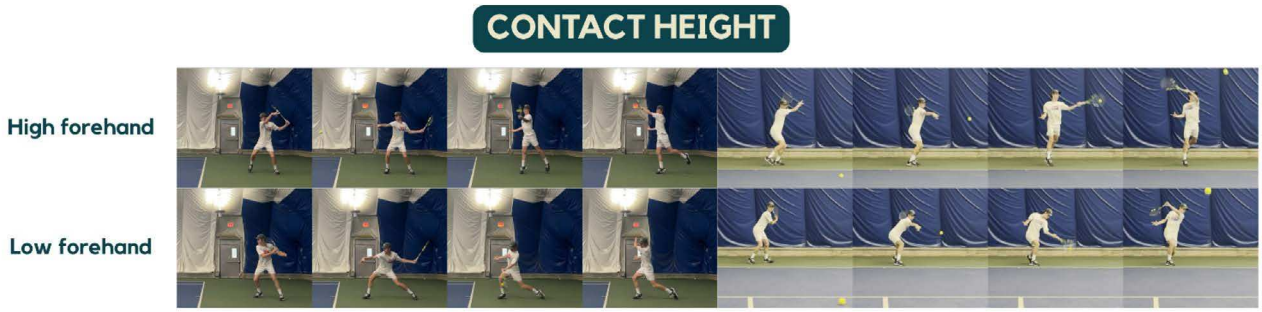
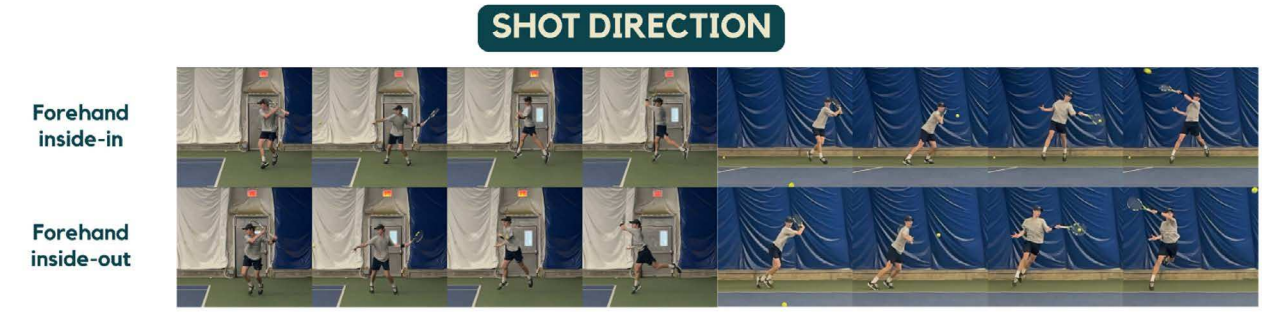


Figure 2. *Examples of the different deceptive contents (deceit, disguise, distraction) across the various roles (active, and contra-active). Adapted from categories offered by Panten et al., (2019), Ramsey et al., (2022), and Zheng et al., (2023) and the degrees of influence offered by (Panten et al., 2019; p.6-7).*





FEELING

	Hit	Jab	Push	Catch	Block
General shot Intention	Used to increase/maintain the speed of the ball.	Used to increase/maintain the speed of the ball.	Used to maximize precision/control.	Used to decrease the speed of the ball.	Used to "maintain" the speed of the ball.
Distinguishing characteristics	Speed before contact.	This is in the hit family, so still speed before contact.	Speed (force) at/after contact.	No racquet speed. Low grip tension.	No racquet speed. High grip tension.
Contact point	Contact well in front allows for acceleration.	Varies based on difficulty of incoming ball.	Contact closer to body to allow for force after contact.	Contact closer to body to allow for passive grip position.	Contact further in front to allow for strong wrist position.

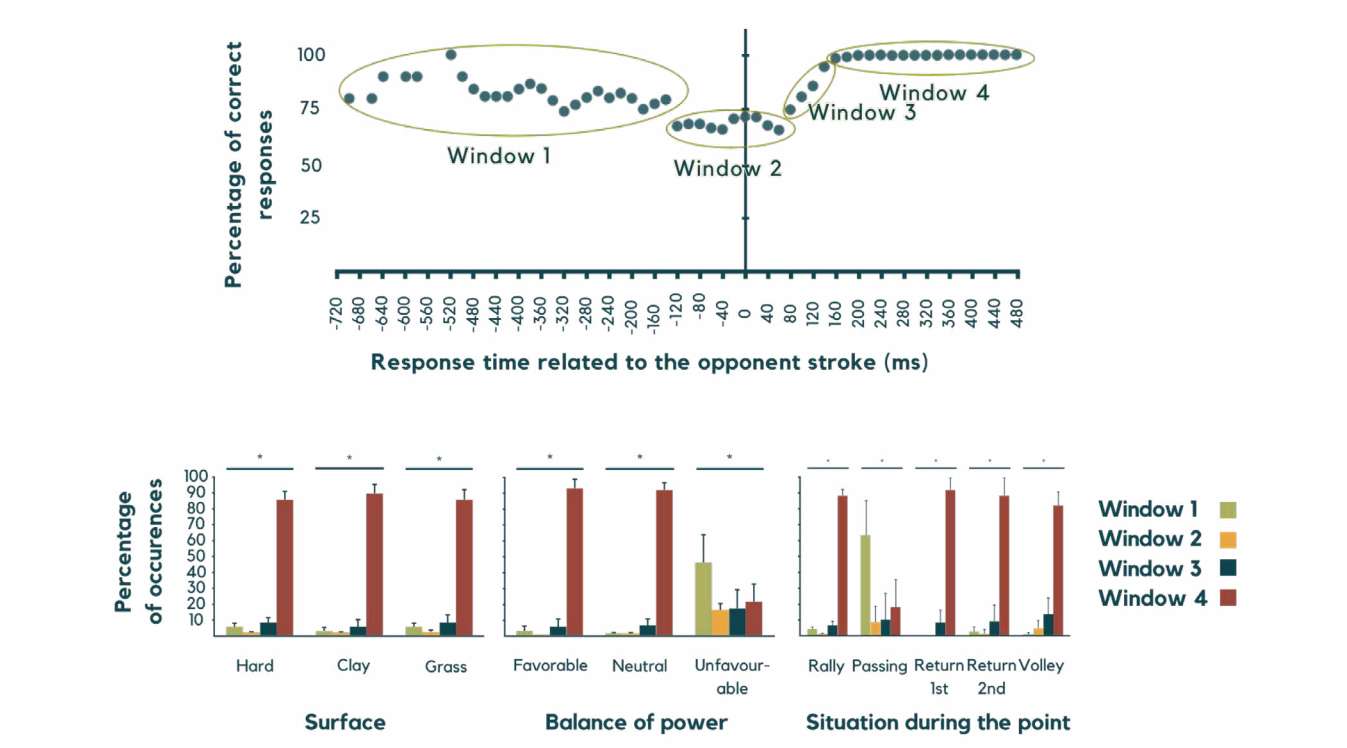


Figure 3. *Top graph: the percentage of correct responses as a function of the response time related to the opponent stroke (t = 0 ms, vertical line) for all surfaces. Bottom graph: the distribution of responses according to the four windows and (A) the three different playing surfaces, (B) the three different balance of power conditions, and (C) the five situations during the point (Triolet et al., 2013).*

movement before executing the genuine intention. Identity deception assimilates sport-specific techniques to create ambiguity. Target deception suggests a target different from the genuine one — typically the opposite. In short, the player exploits where and when they make contact to manipulate where and when the opponent makes contact.

Prerequisites

Active deception requires a player of sufficient skill and a maneuverable racquet, since the time available to transition from deceptive to veridical action is scant. Racquet maneuverability can be improved by developing the player's ability to move the racquet quickly, or by selecting/manipulating racquets to facilitate this. Taraborrelli et al. (2019) note that racquets have trended toward lighter frames with larger heads, making active deception more permissible. It is worth noting that skilled players in racquet sports such as badminton or pickleball, with more maneuverable devices (racquet, paddle, etc) and manageable objects (shuttlecock, ball, etc) employ more frequent and elaborate deception. Beware, if the racquet weight drops too low, the racquet will feel less stable at contact. Task scaling guidelines should be followed for younger athletes to address equipment and environmental constraints appropriately (Buszard, 2022).

Elements of Timing

Effective deception depends on an understanding of timing — defined here as achieving a centered impact, in ideal relation to the body, for the intended shot (according to Larry Jurovich as cited in GBAtennis, 2020a, 2020b). Timing is influenced by three key elements: contact height, intended direction, and the feeling of the swing. Anatomical constraints mean higher contact points occur further away and out in front of the body, while lower contact points occur closer. The direction of a shot is predicated on the body position around the ball, the wrist position at contact, and where in the contact window the player chooses to intercept the ball. The feeling of the swing — whether a hit, jab, push, catch, or block — is also central to timing (see Figure 3).

The active deceiver can create incongruent information using these elements. A player might use a "hit" feeling to execute a drop shot, or contact the ball slightly later in the contact window to disguise direction. In the first example, a swing feeling generally intended to add speed to the ball is used to add spin for a precision attack. The contra-active deceiver can use this same understanding to set traps — for instance, recognizing an opponent preparing a slice with a "hit" feeling and retreating to invite a shorter slice that is difficult to execute with that swing feeling.

Performing Active Kinematic Deception

The player should aim to keep affordances open until as late as possible — delaying the release of specifying information to hold the opponent in suspense. Indicating a higher-percentage option before playing an unlikely one is a reliable application of this principle. The most informative cues an opponent uses to anticipate are precisely the cues worth manipulating. In O'Connell (2026), Bernard Tomic deceives by playing a dropshot with a grip associated with a drive. Ball flight can also be exploited deceptively: movement in the sagittal plane is harder to judge than movement viewed from a different angle. It is trickier to anticipate the opponent's serve if they change their contact points for different serves more parallel to the center line instead of more parallel to the baseline (along the frontal plane). Maintaining similar launch angles across different shot types — analogous to "pitch tunneling" in baseball — can obscure the opponent's perception of the shot. For instance, keeping similar launch angles for a drop shot and a deep slice. Environmental factors such as wind, shadows, and sun can similarly be leveraged deceptively. Finally, the ability to hit closer to lines and the net raises the perceptual challenge for the opponent, particularly under high spatio-temporal demands. Here are examples of deceptive ball flight (ATP Tour, 2021; Australian Open, 2026).

DEFENDING AGAINST DECEPTION

Deception is a powerful disruptor of anticipation (Dimic et al., 2023; Rowe et al., 2009). Understanding where and when it is most likely to occur within a point can help players prepare to counter it. Triolet et al. (2013) found that a player's initial movements to receive the ball was on average 183ms after the opponent's contact and were ~100% successful at 160ms after (opponent's) ball contact (ABC). Movement prior to 160ms ABC (windows 1,2, and 3) was classified as anticipation. Interestingly, anticipation accuracy did not improve linearly as time approached 160ms ABC. Player's movement up to 140ms before (opponent's) ball contact (BBC) was 83% correct and had a higher reliance on contextual information to inform anticipation. Potentially, in this window of time (window 1), the opponent's advantage was so great that the player's anticipation likely would not save them — making the opponent's use of deception redundant. Surprisingly, later anticipation, between 120ms BBC and 60ms ABC (window 2), was characterized by a relatively greater percentage of wrong initial movements by the player (mean = 68% correct). This was largely attributed to the (mis)perception of kinematic/technical information by the player (Triolet et al., 2013), and/or speculatively, deception on the part of the opponent. Notably, this window coincides with what "Schnabel (2007) argued the interval to reorganize movement was 60-100ms" (Panten et al., 2019; p.6). This Window 2 anticipation was most prominent on faster surfaces (grass and hard court), when the player was on defense, and the opponent was approaching/at the net. In this phase of play and game situation, the spatio-temporal demands are greatest on the player and the cost of making a wrong initial movement is offset by their unfavorable odds of winning the point. This could insinuate that professional men are most likely to employ active kinematic deception when they are in control of the point.

In defending against active deception, the player can be certain that the opponent's kinematics must shift from deceptive to genuine intention at contact. The later the opponent makes this shift, and the greater coordinative complexity of the sequential or simultaneous deception to veridical action, the more they are prone to errors. In addition, the player could employ some of their own counter-deception; causing the opponent to take their eye off the ball, resulting in an error or sub-par shot. Finally, assuming the ball is in, until or unless the player is certain it isn't, is a great way to guard against tricky ball kinematics.

While less frequent and less threatening, addressing the contra-active deceiver is important. Recognizing the contra-active deceiver's limited influence on the interaction is a means of avoiding their attempt to disrupt the player's shot. If the player remains sensitive to information over various timescales concurrently they can maximize their grip on the interaction.

Finally, professional players will use the time leading up to the match to become familiar with their opponent — where tactical and technical information is studied by the player and their team. Aspects such as the speculative limitations of a forehand grip to access certain shots, as well as, the probable serving targets on pressure points are noted. Forewarning; relying solely on this offline information that Gibson (1979) calls knowledge about, Stepp & Turvey (2013) call weak anticipation and Zhao and Warren (2014) call heuristics and mapping will not reliably help the player reach the outcomes they desire.

TRAINING CONSIDERATIONS

Critical to the development of deception and anticipation, and their transfer from training to tournaments, is the ED principle of representative training (RT) (Otte et al., 2019). A rote-style practice adhering to an ideal technical template of deception will not develop the tactical awareness of when to apply this skill effectively. Equally, effective deception requires functional variability, since predictable movement patterns are more easily detected. RT is similarly important for anticipation. Buszard (2022; p.2305) asserts that "children can anticipate, but its development is not necessarily a by-product of playing sport and becoming skilled." Without temporal pressure, anticipation is superfluous. Following RT guidelines will elicit and nurture the brinkmanship needed to perform and defend against deception. At minimum, RT will avoid obstructing these skills emergence, as task decomposition and decoupled perception-action training would.

Otte et al. 's (2019) periodization of skill training framework offers practical guidance for scheduling deception and anticipation training relative to the player's stage of learning and competition calendar. Within a session, a coach could look to progress or regress the challenge on the player based upon the dynamical systems concept of (anti)fragility. "A fragile system is one that exhibits more harm than benefits in response to stress whereas an antifragile system is the opposite; the benefits from stress outweigh the harm" (Buszard, 2022; p.2306). The goal of this framework is to keep players in an anti-fragile state by ensuring that they are training under conditions where a slight increase in the challenge produces a greater magnitude of learning than the learning that would occur at an equivalent decrease in challenge.

Another important consideration is improving the player's action capacities so they can better perform and pre-empt deception. While action capacity and skill training go hand-in-hand, developing action capacity is about expanding the affordances available to the player, and skill is about realizing these affordances (Gray, 2022). Factors such as a player's strength relative to their racquet's swing weight is important in their ability to employ active deception. When anticipating, being able to wait longer for more specifying information to become available will more reliably guide action. The option of moving later is partially dependent on the player's agility. Bosch and Cook (2020), and Gray (2022) offer a means of training action capacities in an ED fashion.

TRAINING ACTIVITY

1. One player is approaching the net and the other is passing. Coach feeds in an approach shot. If the approaching player hits a winner they earn a bonus point. If the approaching player hits a winner that bounces three times in the doubles court, they earn two bonus points. Players can switch roles every three points. The approaching player is incentivized to employ deception and the passer attempts to pre-empt it. The coach should modify the feed, incentive structures, and game length so deception and anticipation are intertwined in an anti-fragile state.
2. Finally, a coach could help their player become less susceptible to deception by adequately manipulating the elements of timing outlined in Section C as they play points. The coach could progress and regress the frequency, intensity, and range of deception on their shots so players can learn to combat it while remaining in an anti-fragile state.

CONCLUSION

This paper has defined, described, and offered a means of training to perform and pre-empt kinematic deception in tennis through an ED lens. Kinematic deception — the attempt of one aspect of a system to cause another to lose its negative phase relationship, or incur a positive one — manifests in three subcategories: deceit, disguise, and distraction. Deception can operate actively or contra-actively, and be performed sequentially or simultaneously. Anticipation and deception are best understood together. Anticipation seeks to improve one's own affordances, while deception seeks to undermine the opponent's. Both entail risk, and both become indispensable when competing at the edge of one's ability against a worthy opponent.

Despite the appreciation players and fans have for these skills, coaches need to be both inclined and equipped to teach them — or at least, to avoid obstructing their emergence. The frameworks and evidence presented here offer a foundation for doing so. Further research examining deception and anticipation in singles under representative conditions would meaningfully advance this area. Moreover, research in a doubles setting, or from a more tactical standpoint, or studying the other perceptual forms of deception would provide useful insights on this under-examined, but prevalent skill.

CONFLICT OF INTEREST AND FUNDING.

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