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For the Win: Risk-Sensitive Decision-Making in Teams

JOSH GONZALES,[1] SANDEEP MISHRA[2]* and RONALD D. CAMP II[2]
[1]*Department of Psychology, University of Regina, Regina, Saskatchewan Canada*
[2]*Faculty of Business Administration, University of Regina, Regina, Saskatchewan Canada*

ABSTRACT

Risk-sensitivity theory predicts that decision-makers should prefer high-risk options in high need situations when low-risk options will not meet these needs. Recent attempts to adopt risk-sensitivity as a framework for understanding human decision-making have been promising. However, this research has focused on individual-level decision-making, has not examined behavior in naturalistic settings, and has not examined the influence of multiple levels of need on decision-making under risk. We examined group-level risk-sensitive decision-making in two American football leagues: the National Football League (NFL) and the National College Athletic Association (NCAA) Division I. Play decisions from the 2012 NFL (Study 1; N = 33 944), 2013 NFL (Study 2; N = 34 087), and 2012 NCAA (Study 3; N = 15 250) regular seasons were analyzed. Results demonstrate that teams made risk-sensitive decisions based on two distinct needs: attaining first downs (a key proximate goal in football) and acquiring points above parity. Evidence for risk-sensitive decisions was particularly strong when motivational needs were most salient. These findings are the first empirical demonstration of team risk-sensitivity in a naturalistic organizational setting. Copyright © 2016 John Wiley & Sons, Ltd.

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KEY WORDS risk-sensitivity theory; risk; group dynamics; teams; need; football

Growing evidence suggests individuals make decisions under risk consistent with risk-sensitivity theory: People tend to be risk-prone when they are far from a desired or goal state and risk-averse when close to a desired or goal state (reviewed in Mishra, 2014). However, little is known about whether groups or teams are similarly risk-sensitive, or whether risk-sensitivity is demonstrable in naturalistic settings in humans. Risk-sensitivity has also never before been examined in an organizational context—that is, the context of social collectives seeking to accomplish shared goals (Johns & Saks, 2014). The present investigation is contrasted with extant studies of risk-sensitivity that have been conducted exclusively under controlled laboratory settings (reviewed in Mishra, 2014). Decision-making under risk is ubiquitous in organizations (although surprisingly understudied; Dalal et al., 2010), and much of organizational decision-making occurs in group or team contexts. In the following, we (i) summarize risk-sensitivity theory and empirical evidence supporting it, (ii) review some limitations of risk-sensitivity research to date, (iii) review the data source used (American football plays), and explain why it is well-suited to examining risk-sensitive decision-making in group/team contexts, and (iv) present three studies that empirically examine whether teams make risk-sensitive decisions under conditions of need.

RISK-SENSITIVITY THEORY

Researchers in the behavioral sciences have largely converged on a definition of risk as payoff or outcome variance (e.g., Bernoulli, 1738; Daly & Wilson, 2001; Friedman & Savage, 1948; Mishra, 2014; Mishra, Barclay, & Sparks, in press; Real & Caraco, 1986; Rubin & Paul, 1979; Winterhalder, Lu, & Tucker, 1999). People are generally risk-averse, preferring low variance options to high variance options (Kahneman & Tversky, 1984). Risk-sensitivity theory, however, posits that decision-makers should shift from risk-aversion to risk-preference in situations of high need, where need describes disparity between an individual's present state and goal (or desired) state (Mishra, 2014; Mishra & Lalumière, 2010; Stephens, 1981; Stephens & Krebs, 1986). In such circumstances of disparity, risk-taking allows for obtaining outcomes that might otherwise be unavailable or unattainable. Someone with a pressing $5000 debt, for example, may prefer a gamble with a 10% chance of winning $5000 to earning a certain $500. Both options have the same mean payoff, but only the riskier option allows for a chance to meet one's need. Although simple, risk-sensitivity theory has important practical and applied implications given that almost all decisions involve some consideration of a required or desired outcome or goal. Unlike other decision-making theories which focus on maximization (e.g., expected utility theory and prospect theory; Friedman & Savage, 1948, 1952; Kahneman & Tversky, 1979; Tversky & Kahneman, 1981), risk-sensitivity theory is focused on satisficing. Decision-makers are considered to be primarily focused on meeting their needs, not maximizing utility independent of context (Mishra, 2014).

A growing body of evidence indicates that people make decisions under risk consistent with risk-sensitivity theory (Deditius-Island, Szalda-Petree, & Kucera, 2007; Ermer, Cosmides, & Tooby, 2008; Mishra, Barclay, & Lalumière, 2014; Mishra & Fiddick, 2012; Mishra, Gregson, & Lalumière, 2012; Mishra & Lalumière, 2010; Mishra, Son Hing, & Lalumière, 2015; Pietras & Hackenberg, 2001; Pietras, Locey, & Hackenberg, 2003; Rode, Cosmides, Hell, & Tooby, 1999; Wang, 2002; reviewed in Mishra, 2014). For

*Correspondence to: Sandeep Mishra, Faculty of Business Administration, University of Regina, Regina, Saskatchewan, S4S0A2. E-mail: mishrs@gmail.com

example, Mishra and Lalumière (2010) demonstrated that people engaged in greater risk-taking when under conditions of high need involving both decisions from description (i.e., decisions involving explicit descriptions of possible outcomes) and decisions from experience (i.e., decisions involving implicit learning of possible outcomes). Furthermore, in this study, participants consistently shifted from risk-aversion to risk-proneness in high need situations despite stable individual differences in personality traits associated with risk-taking (i.e., impulsivity, sensation-seeking, and low self-control; Mishra & Lalumière, 2010).

LIMITATIONS IN THE EXTANT RISK-SENSITIVITY LITERATURE

Although the evidence reviewed above suggests that risk-sensitivity theory is a promising framework for understanding decision-making under risk, there remain key limitations in the extant literature. Specifically, issues of external validity, multiple levels of need, and applicability to group context have not yet been addressed.

External validity

Risk-sensitivity in humans has been almost exclusively examined in laboratory settings using experimental designs (but see Wang & Johnson, 2012). These research designs offer excellent internal validity, control, and the ability to make causal conclusions. However, the external validity of risk-sensitivity has yet to be examined, and no studies have investigated risk-sensitivity in a naturalistic setting among humans.

Multiple levels of need

Many theories of decision-making involve either explicit or implicit consideration of reference points, including prospect theory and risk-sensitivity theory (e.g., Kahneman & Tversky, 1979; Mishra, 2014; Mishra & Fiddick, 2012; Tversky & Kahneman, 1981). Recent research indicates that both human and non-human decision-makers take into consideration multiple reference points when making decisions (e.g., Heath, Larrick, & Wu, 1999; Hurly, 2003; Liu & Colman, 2009; March & Shapira, 1992; Sullivan & Kida, 1995; reviewed in Koop & Johnson, 2012). Furthermore, research indicates that people are able to consider these multiple reference points simultaneously when making decisions (Ordóñez, Connolly, & Coughlin, 2000). In the context of risk-sensitivity theory, these reference points are conceptualized as need levels that decision-makers are motivated to meet or exceed. It is therefore likely that decision-makers are motivated by multiple levels of need at any given time. Indeed, some experimental evidence suggests that people make risk-sensitive decisions when faced with multiple reference points (Koop & Johnson, 2012). However, little research has formally examined whether multiple reference points motivate risk-sensitive decision-making.

Group decision-making

Groups do not necessarily make choices in the same way that individuals do. There are changes in process, motivation, and stress, in addition to the introduction of such emergent behavioral phenomena as in-group bias and shared mental models (reviewed in Kerr & Tindale, 2004). Some studies have shown that groups are better than individuals at identifying incorrect information and are more likely to reject incorrect information (Rajaram, 2011). Being in a group also diversifies opinion and allows for problem solving that would not necessarily be effective or feasible at the individual level (Wanous & Youtz, 1986). However, groups are also more subject to distraction and tend to focus on information only known among group members, resulting in a decrease in efficiency (Di Salvo, Nikkel, & Monroe, 1989; Stasser & Titus, 1985; Steiner, 1972). Especially relevant to risk-sensitive decision-making is the finding that groups often make simple inadequate decisions when faced with a time pressure (Zander, 1994). It is presently unclear whether groups make risk-sensitive decisions sensitive to need similar to individuals.

STUDY CONTEXT: ORGANIZATIONAL DECISION-MAKING IN FOOTBALL

We examined in-game risk-sensitive behavior of teams in two competitive American football leagues: the National Football League (NFL) and the National College Athletic Association (NCAA) Division I football league. Sports have long been an underutilized way of studying organizational behavior (reviewed in Day et al., 2012; Katz, 2001; Wolfe et al., 2005). Sports teams, like other organizational teams, must collaborate in order to meet superordinate goals tied to performance outcomes (that in turn are tied to individual-level compensation; Johns & Saks, 2014). However, unlike many other organizational settings, sports offer well-structured problem spaces with clearly defined goals and rules (Simon, 1956, 1973). The meticulous caretaking of archival data in major sports is virtually unparalleled in any other organizational setting. By using archival data sets of football plays we are able to examine, with extremely high statistical power, risk-sensitivity in real-world decision-making.

More specifically, NFL, and NCAA football plays lend themselves well to an analysis of risk-taking because football involves repeated binary choices between low-risk (run) and high-risk (pass) options. Football consists of a discrete series of plays where a team on offense has two primary options: passing or running. Passing the ball has higher outcome variance (and is thus “riskier”) than running the ball given that passing can result in a larger number of potential outcomes. Football also necessarily involves decision-making under multiple levels of need in a team context. In the following, we detail the decision-making processes involved in football.

Basic football game structure

Football is based on multiple levels of well-defined needs. Football is a zero-sum game, with a binary winner/loser outcome. At any point in a game, one team has the ball and is

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considered the offensive team, while the other team attempts to stop the offense and is considered the defensive team. At its base level, football is about moving the football in one direction while your opponent is trying to move the football in the opposite direction. This process is called "gaining yards" and the yards a team is able to gain are a key in-game currency of football decision-making.

In the NFL and NCAA, an offensive team gets four attempts, called "downs", to reach a certain marker. This marker (the "first down marker") is typically placed 10 yards away from the team's starting point on their first down.[1] If the team fails to reach the first down marker on first down, they are considered to be on their second down. If they fail on their second down they move to their third down; failure at that point results in the team's fourth, and final, down of a possession. If the offensive team reaches the first down marker before the end of their fourth down they receive a new set of downs, starting at the last yard gained, and again start from a first down try. Teams can attempt to run or pass on a fourth down, but typically elect to call a play called a "punt", where a designated player kicks the ball further down the field (with control of the ball ceded to the opposing team). If an offensive team attempts to run or pass on a fourth down and fails, the opposing team receives the ball at the yard marker where the offensive team last had control. Teams continue to attain new downs until the team has scored or loses possession of the ball. Getting first downs is the lowest level of need in football.

Eventually, by gaining enough yards, an offensive team reaches an area of the field where being able to score points becomes possible, and therefore the need to score becomes as salient as the need to attain first downs. Points can be scored by either a field goal or a touchdown. A field goal, worth three points, is completed by having a player kick the ball through a set of upright posts stationed at the end of the field. A touchdown, worth a potential seven points, occurs when a player from the offensive team crosses the "goal line", stationed near the opponents end of the field.[2]

The primary need in any individual football game is to gain more points than the other team in order to win the game. In the NFL, the point of winning games is to eventually qualify for a playoff spot. Once in the playoffs, teams play in an elimination tournament to progress to a championship game. At the time data for this study was collected, NCAA Division I football champions were determined differently. Teams were ranked subjectively by external sources on the quality of their wins (i.e., strength of schedule, beating subpar teams with a wide margin of victory, and winning against highly ranked opponents) in order to compete in "bowl games". The two teams that were highest ranked competed for the Division I national championship.

[1]If a penalty is called, a team's starting point may shift further or closer to the first down marker depending on which team is penalized and what type of penalty is enforced.

[2]A touchdown is initially worth six points. However, the offensive team is then immediately given the chance to gain either one extra point by kicking the ball through the uprights or two extra points by attempting to get another "touchdown". The single extra point is typically taken due to its higher probability of success, but there are situations where it is beneficial to attempt to receive two points (e.g., when a team is still down by two points after gaining the initial six touchdown points).

Hierarchy of needs

An overarching goal of every team in the NFL and NCAA is to win championships. In order to meet this goal, multiple levels of need must be consistently attained. A team does not get to a championship without first making the playoffs. A trip to the playoffs does not occur unless a team consistently wins games. To win games, a team must consistently outscore their opponents, and they cannot score points without keeping possession of the ball by gaining new downs.[3] The only way to accrue a new set of downs is to gain football's primary currency: yards. Lower level "in-game" needs (i.e., points and downs) must therefore be consistently attended to in order to reach higher-level team goals.

In-game reference points

Because football is exacting in its structure, first down attainment and point disparity act both as explicit reference points and as explicit team needs. If a team fails to attain a first down (after four attempts) they fail to keep possession of the ball. This requirement can be equated to a "bottom line" goal state (as characterized in some multiple reference point models; e.g., Koop & Johnson, 2012). The further a team is from attaining a first down, the higher their need. Need salience is contingent on the current down attempt. If a team is on a later down (e.g., a third or fourth down attempt), with many yards to go to complete the down attempt, teams should be more risk-sensitive (i.e., one would observe a stronger correlation between yards-to-down and risky passing plays). Similarly, if a team fails to score more points than their opponent by the end of the game they lose. The more points a team is losing by, the higher their need. This is also a "bottom line" goal state. As is the case for yards-to-down, a high point disparity would lead to the observation of greater risk-sensitivity (a stronger correlation between point disparity and risky passing plays). There are no aspirational (i.e., "optional") goals in a football game. Every in-game decision made by a team is "for the win". To reach the goal state of winning, decisions involving risk must constantly be made.

Discrete decisions under risk

At an individual offensive play-calling level, football involves a dichotomous choice between a relatively low variance (low risk) option of running and a relatively higher variance (high risk) option of passing. Passing is higher variance than running because a completed pass typically gains more yards than a run, but there is also a chance the pass is incomplete at which point the offensive team gains zero yards. The data we present later in the manuscript confirms that in our three samples, passing involves higher outcome variance than running.

[3]Teams can also score off kick/punt returns, kick/punt blocks, safeties, interceptions, and fumbles, but these are rare events.

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Group-level decisions

It is a common misconception that decision-making in football is solely attributable to the head coach. Rather, football decisions are the necessary products of multiple individual inputs. As a group, teams outline strategic plans called "game plans" the week before the game starts (Billick, 1997). These plans include various play options a team may employ in any given scenario based on strengths and weaknesses of the team and their opponent. During the preparation phase of the game plan, many members of the team and coaching staff are afforded the opportunity to bring up ideas or concerns. Billick (1997) notes, "it would be foolish to not utilize [the group of coaches'] capabilities by excluding them from the creation and implementation of game plans" (p. 10). Once the game has started, in-game offensive play-calling decisions principally involve the head coach, the offensive coordinator, and the quarterback, but decisions are still chiefly informed by the "game plan" prepared ahead of time. Decisions also involve regular input from players on the field and ancillary coaching staff.

A typical in-game decision-making process proceeds as follows. First, the offensive coordinator chooses a play from the game plan that he believes will succeed given the constraints of the game. While the head coach is tasked with overseeing all aspects of the game, the offensive coordinator is exclusively focused on the competitive intelligence directly related to the offense and its schemes. The offensive coordinator's choice of play is then considered (and potentially revised) by the head coach, who may overrule the decision and choose an alternative play. The coaching staff's choice of play is then presented to the quarterback, who then sometimes receives feedback from other players during huddles (especially in key high need situations). The quarterback typically elects to run the play given to him from the coaches, but also has the choice to switch to another play within the game plan.

From an outsider's perspective, the head coach is typically considered the central figure of decision-making in football. However, unless the head coach also acts as the offensive coordinator (which is rare at the NFL and NCAA levels), at least three people are necessarily involved in the decision-making process for every offensive play call. Furthermore, the set of plays chosen from in-game are a product of a larger group decision-making process of creating a game plan. Consequently, football plays and their outcomes are necessarily a product of emergent group-level decision-making (in contrast to any one individual's decision-making process). Perhaps the best analogy is that a head coach serves as the "chief executive officer" in decision-making, but engages in participative leadership with in-game decisions being informed by the integrated input of ancillary staff and players.

OVERVIEW OF THE CURRENT STUDIES

Previous research on risk-sensitive decision-making has only examined individual-level decision-making in laboratory settings. We sought to extend these findings through examination of three archival data sets of actual risk-sensitive decisions obtained from two major competitive football leagues in the United States (the NFL and NCAA). Our studies extend previous research in three important ways. First, we address the distinct lack of external validity in the risk-sensitivity literature by examining decision-making patterns in a large sample of real-world decisions. Second, we examine whether multiple levels of need motivate risk-sensitive decision-making. Third, we examine risk-sensitive decision-making in an organizational group context. Broadly, we hypothesize that (i) groups make risk-sensitive decisions consistent with risk-sensitivity theory, meaning they become risk-prone when faced with high need real-world scenarios in order to meet superordinate team goals, and (ii) groups consider multiple reference points of need while making risk-sensitive decisions. In the present study, these hypotheses manifest in the specific predictions that (i) teams will show increased risk-sensitivity with regards to yards-to-down as downs increase (with a peak in risk-sensitivity at the 4th down), and (ii) teams will show increased risk-sensitivity with regards to points-to-parity as the game quarters progress (with a peak in risk-sensitivity at the 4th quarter). In all circumstances, greater risk-sensitivity is quantified by increased risk-taking in response to conditions of high need.

STUDY 1: RISK-SENSITIVE DECISION-MAKING IN THE NFL (2012)

In Study 1, we examined whether NFL teams make risk-sensitive decisions at the play-by-play level. Offensive football teams make a series of choices between a lower variance (low-risk) option of running and a higher variance (high-risk) option of passing. Risk-sensitivity theory predicts that teams should pass instead of run under conditions of high need. Consequently, we predicted that risk-taking as measured by the decision to pass instead of run would be positively associated with yards-to-down (i.e., the number of yards needed in order to attain a new set of downs). However, because teams get four attempts to attain a first down, we further predicted that this association would be higher for third and fourth downs due to the reduction of opportunities to attain new first downs. We also predicted that risk-taking would be positively associated with point disparity (points of defensive team minus the points of offensive team). Teams have four quarters to reduce point disparity. Therefore, we further predicted that the association between risk-taking and point disparity would be stronger late in the game. These predictions were formed with consideration for two motivational need levels: the "down" level (which involves a specific concern for yards gained) and the "win the game" level (which involves a specific concern for point disparity).

METHOD

Game charting data of the 2012 NFL season was obtained from footballoutsiders.com, one of the leading data-analysis groups of football performance on the internet. All 32 teams in the league were included in the analysis. All regular season games, from week one through week 17, were analyzed. A total of 33 944 offensive plays were examined. The

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following measures were collected for each offensive play by both competing teams in each game: down (one through four), distance (in yards) to attaining a first down (denoted "yards-to-down"), quarter (one through four, plus overtime), and points-to-parity (i.e., score disparity, either positive or negative). The actual categorical pass (coded as one) or run (coded as zero) decision that concluded each offensive play was the dependent measure of risk-taking in all analyses.

RESULTS AND DISCUSSION

Detailed descriptive statistics for proportion of risky plays (passes) and yards gained across various game contexts in all three samples are provided in supplementary materials (Tables S1–S2, S4–S9). An independent-samples *Kolmogorov-Smirnov* test indicated that, as predicted, passing the ball resulted in significantly higher variance in yards gained than running the ball (run: $M = 4.46$, $SD = 6.57$; pass: $M = 6.08$, $SD = 9.99$; $p < .001$). The mean yards gained from pass and run plays did not significantly differ, $z = 1.24$, $p = .22$.

We predicted that decision-makers would be more likely to pass (versus run) as the number of yards needed to attain a first down increased, particularly in later downs. Across all downs, a significant positive association between yards-to-down and risk-taking (i.e., the decision to pass instead of run) was observed, $r_s(33\,942) = .04$, $p < .001$. As down increased, the association between yards-to-down and risk-taking also increased; first down: $r_s(14\,966) = .07$, $p < .001$; second down: $r_s(11\,334) = .22$, $p < .001$; third down: $r_s(7\,182) = .29$, $p < .001$; fourth down: $r_s(462) = .55$, $p < .001$. The magnitude of the association between yards-to-down and risk-taking significantly differed between all downs (as examined using Fisher's *r*-to-*z* transformations), all $zs > 4.97$, $ps < .001$, indicating that risk-sensitivity increased as downs increased (Table 1).

Together, these results demonstrate that NFL football teams become increasingly more risk-sensitive as need (at the yard disparity level) becomes more salient (Figure 1).

We also predicted decision-makers would make risk-sensitive decisions regarding points-to-parity, especially in late game situations. Across all quarters, a significant association between points-to-parity and risk-taking was observed, $r_s(33\,942) = .17$, $p < .001$, supporting this hypothesis. As quarters progressed (with the exception of overtime), the association between points-to-parity and risk-taking also increased; first quarter: $r_s(7740) = .03$, $p = .03$; second quarter: $r_s(8995) = .05$, $p < .001$; third quarter: $r_s(7895) = .09$, $p < .001$; fourth quarter: $r_s(8971) = .40$, $p < .001$; overtime: $r_s(462) = .07$, $p = .21$. All associations significantly differed from each other, with two exceptions (Table 2): The association in the first quarter did not significantly differ from the association in the second quarter, and the associations in overtime did not significantly differ from any of the quarters (except the fourth quarter, where the correlation was particularly high).

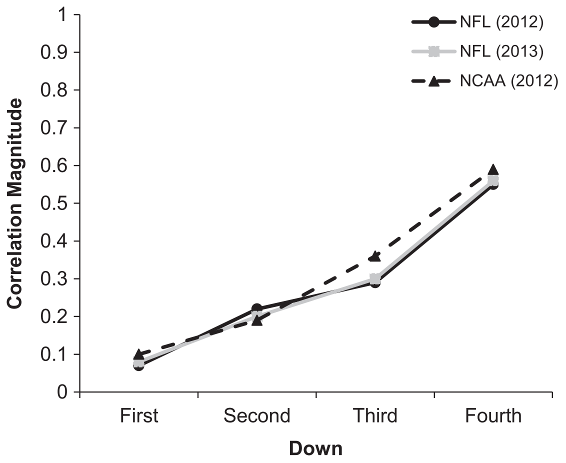

Figure 1. Spearman correlations of risk-taking (passing instead of running) and need level (yards to first down), by need salience (down) in National Football League (NFL) and National College Athletic Association (NCAA) games. The magnitude of the correlations increased as salience (down) increased

The largest correlation between points-to-parity and risk-taking was observed in the fourth quarter, where the need to win the game was most salient. This finding indicates that teams are particularly risk-sensitive under strong conditions of need (Figure 2). The association between points-to-parity and risk-taking in overtime was not statistically significant, which is not surprising: Teams only go into overtime if the score is tied and the parameters of winning the game change (i.e., the first team to score wins) therefore making score disparity irrelevant.

An exploratory logistic regression was conducted on all variables after mean centering. The model was significant, $\chi^2(8) = 131.09$, $p < .001$. The model explained 16.5%

Table 1. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (yards to first down), by need salience (down), using Fisher *r*-to-*z* transformations (all comparisons two-tailed) in 2012 National Football League games (Study 1)

	1st Down	2nd Down	3rd Down
2nd Down	$z = 12.33$ ($p < .001$)		
3rd Down	$z = 15.91$ ($p < .001$)	$z = 4.97$ ($p < .001$)	
4th Down	$z = 11.57$ ($p < .001$)	$z = 8.29$ ($p < .001$)	$z = 6.64$ ($p < .001$)

Table 2. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (score disparity), by need salience (quarter), using Fisher *r*-to-*z* transformations (all comparisons two-tailed) in 2012 National Football League games (Study 1)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2nd Quarter	$z = 1.29$ ($p = .20$)			
3rd Quarter	$z = 3.76$ ($p < .001$)	$z = 2.61$ ($p = .009$)		
4th Quarter	$z = 25.37$ ($p < .001$)	$z = 25.03$ ($p < .001$)	$z = 21.60$ ($p < .001$)	
Overtime	$z = .83$ ($p = .41$)	$z = .42$ ($p = .67$)	$z = .31$ ($p = .76$)	$z = -7.39$ ($p < .001$)

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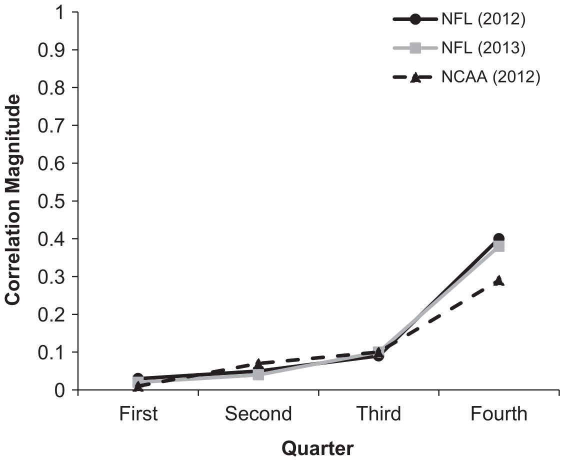

Figure 2. Spearman correlations of risk-taking (passing instead of running) and points-to-parity, by quarter (from the first quarter, to the last, and final fourth quarter), in National Football League (NFL) and National College Athletic Association (NCAA) games. The magnitude of the correlations increased as salience (quarter) increased

(Nagelkerke R^2) of the variance in risk-taking and correctly classified 65.6% of cases. All variables and interactions were significant (all ps < .04) except for the three-way interactions (yards-to-down × down × quarter, p = .84; gap × quarter × down, p = .15). Full results are reported in supplementary materials (Table S10). Together, the results of Study 1 demonstrate that NFL football teams (in 2012) made risk-sensitive decisions at two distinct levels of need: the first down level, and the "win the game" level. Teams were particularly risk-sensitive when needs were most salient (i.e., at fourth downs and in the fourth quarter). Additional descriptive statistics and analyses for all three studies are provided in supplementary material.

STUDY 2: RISK-SENSITIVE DECISION-MAKING IN THE NFL (2013)

Given current concerns over lack of replication in the behavioral sciences (e.g., Pashler & Wagenmakers, 2012), we sought to directly replicate findings from Study 1 in a sample of NFL plays in a different year (2013). Our predictions were the same as in Study 1.

METHOD

All methods were identical to Study 1, except that data from the 2013 NFL season was analyzed. A total of 34 087 offensive plays were examined.

RESULTS AND DISCUSSION

An independent-samples *Kolmogorov-Smirnov* test indicated that, as predicted, passing the ball resulted in significantly higher variance in yards gained than running the ball (run: M = 4.37, SD = 6.35; pass: M = 6.02, SD = 10.19; p < .001). Unlike Study 1, the mean number of yards gained from pass and run plays significantly differed, z = 2.13, p = .03.

Across all downs, a significant association between yards-to-down and risk-taking (i.e., the decision to pass instead of run) was observed, $r_s(34\,087) = .05$, $p < .001$. As down increased, the association between yards-to-down and risk-taking also increased; first down: $r_s(15\,030) = .08$, $p < .001$; second down: $r_s(11\,360) = .20$, $p < .001$; third down: $r_s(7\,212) = .30$, $p < .001$; fourth down: $r_s(485) = .56$, $p < .001$ (Figure 1). All associations among downs significantly differed (as tested using Fisher's r-to-z transformations; all zs > 6.87, ps < .001; Table 3).

As in Study 1, the largest correlation between risk-taking and yards-to-down was observed for the fourth down. This result again demonstrates that when the need to attain a first down is most salient, teams are more risk-sensitive. Together, our results indicate that NFL football teams in 2013 made decisions consistent with risk-sensitivity theory at the yard disparity level, replicating the results of Study 1 (Figure 2).

Across all quarters, a significant association between points-to-parity and risk-taking was observed, $r_s(34\,087) = .16$, $p < .001$. As quarters progressed (with the exception of overtime), the association between points-to-parity, and risk-taking increased; first quarter: $r_s(7767) = .02$, $p = .20$; second quarter: $r_s(9024) = .04$, $p < .001$; third quarter: $r_s(8001) = .10$, $p < .001$; fourth quarter: $r_s(9023) = .38$, $p < .001$; overtime: $r_s(272) = .002$, $p = .97$. When we compared the correlation coefficients using Fisher's r-to-z transformations, we found the same pattern of results as in Study 1: The association in the first quarter did not significantly differ from the association in the second quarter, and overtime did not significantly differ from any of the quarters (except the fourth quarter, where the correlation was particularly high). All other differences were significant (Table 4).

As in Study 1, the largest correlation between risk-taking and points-to-parity was observed in the fourth quarter where the need to win the game was most salient (Figure 2). An exploratory logistic regression was conducted on all variables after mean centering. The model was significant, $\chi^2(8) = 118.68$, $p < .001$. The model explained 15.6% (Nagelkerke R^2) of the variance in risk-taking and correctly classified 65.6% of cases. All variables and interactions were significant (all ps < .05) except for the four-way interaction (yards-to-down × down × point disparity × quarter, p = .40). Full results are reported in supplementary materials (Table S11).

Table 3. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (yards to first down), by need salience (down), using Fisher r-to-z transformations (all comparisons two-tailed) in 2013 National Football League games (Study 2)

	1st Down	2nd Down	3rd Down
2nd Down	z = 9.86 (p < .001)		
3rd Down	z = 16.01 (p < .001)	z = 7.09 (p < .001)	
4th Down	z = 11.94 (p < .001)	z = 9.25 (p < .001)	z = 6.87 (p < .001)

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Table 4. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (score disparity), by need salience (quarter), using Fisher *r*-to-*z* transformations (all comparisons two-tailed) in 2013 National Football League games (Study 2)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
2nd Quarter	$z = 1.29$ ($p = .20$)			
3rd Quarter	$z = 5.04$ ($p < .001$)	$z = 3.93$ ($p < .001$)		
4th Quarter	$z = 24.55$ ($p < .001$)	$z = 24.18$ ($p < .001$)	$z = 19.51$ ($p < .001$)	
Overtime	$z = .29$ ($p = .77$)	$z = .61$ ($p = .54$)	$z = 1.59$ ($p = .11$)	$z = 6.43$ ($p < .001$)

We observed a significant mean difference in yards gained between pass and run plays in Study 2. This finding suggests that teams may have chosen the pass option not because it is higher variance (and thus riskier), but rather, to gain a greater expected value of yards. However, if teams were insensitive to risk, the correlations between risky choice and yards-to-down and points-to-parity would be non-significant. Yet we see that teams adjust their choices based on game circumstances consistent with risk-sensitivity theory.

Together, the results of Study 1 and Study 2 indicate that NFL football teams make risk-sensitive decisions at both the first down level and the "win the game" level. These results suggest that teams are primarily risk-sensitive when needs are most salient (i.e., at the fourth down and fourth quarter levels); that is, teams elevate their level of risk-taking under the most salient conditions of high need.

STUDY 3: RISK-SENSITIVE DECISION-MAKING IN THE NCAA (2012)

Studies 1 and 2 demonstrated that NFL football teams make risk-sensitive decisions at two levels of needs: the down level, and the "win the game" (i.e., points-to-parity) level. Study 3 sought to examine whether these relationships replicate in a different population. Specifically, Study 3 examined whether NCAA football teams make collective risk-sensitive decisions similar to those demonstrated by NFL teams. This examination of risk-sensitivity in NCAA football teams is particularly interesting given that there are several key incentive differences (relative to the NFL), and NCAA teams have much higher variability in quality of players (due to larger rosters and a less stringent recruitment system compared with the rigorous NFL draft of elite college players). A demonstration of risk-sensitivity in this second population would thus demonstrate the robustness of risk-sensitivity theory in explaining risky choice in football games.

In the NFL, teams need to win enough games by the end of the season to qualify for a playoff spot. Once in the playoffs, teams play in an elimination tournament to progress to a championship game. In the NCAA, champions are determined differently (or at least were determined differently in 2012 for the teams examined in this manuscript; ranking rules have since changed). In 2012, external committees ranked teams subjectively by the quality of their wins (i.e., strength of schedule, beating subpar teams with a wide margin of victory, and winning against highly ranked opponents). Top ranked NCAA teams have the opportunity to compete in "bowl games", which are showcase games that, in 2012, were only given to teams with non-losing records. Teams in bowl games are able to further increase their revenue and prestige, which improve future recruiting, creating a virtuous circle for successful programs. The two teams that rank highest compete for the NCAA national championship. Rule differences between the NFL and NCAA (e.g., in the NCAA a receiver only needs to keep one foot inbounds for a pass to be considered complete; the clock stops after attaining a first down) also facilitate slight in-game strategy changes compared with the NFL.

In Study 3, we sought to replicate and extend results from Study 1 and Study 2 through examination of actual risk-sensitive decisions in NCAA games. We had the same predictions as in Study 1 and Study 2.

METHOD

Game charting data of the 2012 NCAA season was obtained from footballoutsiders.com. Seventy-five different Division I teams were included in the analysis. One hundred and nine games were analyzed, including divisional championship and bowl games. The games that footballoutsiders.com charted were decided by the likelihood they would be written about, therefore biasing the sample to the "biggest" and/or most relevant games of the season. This charting, however, has the positive consequence of measuring a set of plays that occur under the most salient need conditions.

A total of 15 250 offensive plays were analyzed. The following measures were collected for each offensive play by both competing teams in each game: down (one through four), distance (in yards) to attaining a first down (denoted "yards-to-down"), quarter (one through four, plus single, and double overtime), points-to-parity (i.e., score disparity, either positive or negative). The actual categorical pass (coded as one) or run (coded as zero) decision that concluded each offensive play was the dependent measure of risk-taking in all analyses.

RESULTS AND DISCUSSION

As in Studies 1 and 2, we conducted analyses to examine whether passing was riskier than running. An independent-samples *Kolmogorov-Smirnov* test indicated that, as predicted, passing the ball resulted in significantly higher variance in yards gained than running the ball (run: $M = 5.09$, $SD = 7.91$; pass: $M = 10.03$, $SD = 12.13$; $p < .001$). The number of yards gained from pass and run plays significantly differed, $z = 33.77$, $p < .001$.

We predicted that decision-makers would be more likely to pass (versus run) as the yards needed to attain a first down

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Table 5. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (yards to first down), by need salience (down), using Fisher r-to-z transformations (all comparisons two-tailed) in 2012 National College Athletic Association games (Study 3)

	1st Down	2nd Down	3rd Down
2nd Down	$z = .4.95$ ($p < .001$)		
3rd Down	$z = 12.75$ ($p < .001$)	$z = 8.09$ ($p < .001$)	
4th Down	$z = 9.72$ ($p < .001$)	$z = 8.12$ ($p < .001$)	$z = 4.94$ ($p < .001$)

increased, particularly in later downs. Across all downs, a significant association between yards-to-down and risk-taking (i.e., the decision to pass instead of run) was observed, $r_s(15\,250) = .09$, $p < .001$. As down increased, the association between yards-to-down and risk-taking also increased; first down: $r_s(6777) = .10$, $p < .001$; second down: $r_s(5074) = .19$, $p < .001$; third down: $r_s(3100) = .36$, $p < .001$; fourth down: $r_s(299) = .59$, $p < .001$ (Figure 1). When we compared the magnitude of correlation between risk-taking using Fisher's r-to-z transformations, we found significant differences among all downs (all zs > 4.94, ps $< .001$; Table 5).

An exploratory logistic regression was conducted on all variables after mean centering. The model was significant, $\chi^2(8) = 43.18$, $p < .0001$. The model explained 10.9% (Nagelkerke R^2) of the variance in risk-taking and correctly classified 62.0% of cases. All variables and interactions were significant (all ps $< .01$) except for the following: yards-to-down × quarter ($p = .52$), point-disparity × down ($p = .12$), yards-to-down × down × quarter ($p = .88$), and point-disparity × quarter × down ($p = .21$). Full regression results are presented in supplementary material (Table S12).

As in Studies 1 and 2, the largest correlation between risk-taking and yards-to-down was observed for the fourth down. This result indicates that when the need to attain a first down is most salient, teams became more risk-sensitive. Together, our results indicate that NCAA football teams make decisions in line with risk-sensitivity theory at the yard disparity level, replicating the results of Study 1 and Study 2.

We also predicted that decision-makers would make increasingly more risk-sensitive decisions regarding points-to-parity, especially in late game situations. Across all quarters, a significant association between points-to-parity and risk-taking was observed, $r_s(15\,250) = .13$, $p < .001$. As quarters progressed (with the exception of the two overtimes), the association between points-to-parity and risk-taking increased; first quarter: $r_s(3732) = .01$, $p = .65$; second quarter: $r_s(4120) = .07$, $p < .001$; third quarter: $r_s(3725) = .10$, $p < .001$; fourth quarter: $r_s(3662) = .29$, $p < .001$; first overtime: $r_s(40) = .19$, $p = .24$; second overtime: $r_s(11) = .28$, $p = .40$. All associations significantly differed except for the comparison between the second and third quarters, and all comparisons involving the two overtimes (Table 6).

As in Studies 1 and 2, the largest correlation between risk-taking and points-to-parity was observed in the fourth quarter where the need to win the game was most salient (Figure 2). The small sample sizes of the first and second overtime ($N = 44$ and $N = 11$, respectively) were not large enough to allow for meaningful analysis.

As in Study 2, we observed a significant mean difference in yards gained between pass and run plays in the NCAA sample. However, teams made risk-sensitive decisions even though the highest expected value of yards gained for any given play decision would be obtained through a pass play. In both the NFL and the NCAA, teams are risk-sensitive regardless of the differences in expected value between pass and run plays. These results demonstrate the consistency and robustness of support for risk-sensitivity theory.

Together, the results of Study 3 indicate that NCAA football teams make risk-sensitive decisions at both the first down level and the "win the game" level similar to NFL teams. Furthermore, as demonstrated in Studies 1 and 2, results suggest that teams are primarily risk-sensitive when needs are most salient (i.e., at the fourth down and fourth quarter levels); that is, teams elevate their level of risk-taking under the most salient conditions of high need.

GENERAL DISCUSSION

Across three studies, we show that football teams in the NFL and NCAA make risk-sensitive decisions consistent with risk-sensitivity theory. When under salient conditions of high need, teams elevated risk-taking by choosing higher variance plays (i.e., passing over running). These results represent the first empirical evidence in support of risk-sensitivity in a naturalistic organizational setting, as well as the first evidence that groups make collective decisions that are risk-sensitive. Across all studies, we demonstrated that teams make risk-sensitive decisions at two levels of need: the need to gain first downs and the need to outscore the opposing team.

Greater risk-taking was observed under salient conditions of high need (i.e., when teams were about to turn the ball over to the opposing team on downs, or were about to lose games).

Table 6. Magnitude differences of correlations examining the association between risk-taking (passing instead of running) and need level (score disparity), by need salience (quarter), using Fisher r-to-z transformations (all comparisons two-tailed) in 2012 National College Athletic Association games (Study 3)

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Overtime
2nd Quarter	$z = 2.66$ ($p = .008$)				
3rd Quarter	$z = 3.90$ ($p < .001$)	$z = 1.34$ ($p = .18$)			
4th Quarter	$z = 12.40$ ($p < .001$)	$z = 10.06$ ($p < .001$)	$z = 8.51$ ($p < .001$)		
1st Overtime	$z = 1.1$ ($p = .27$)	$z = .74$ ($p = .46$)	$z = .56$ ($p = .58$)	$z = .64$ ($p = .52$)	
2nd Overtime	$z = .78$ ($p = .44$)	$z = .61$ ($p = .54$)	$z = .53$ ($p = .60$)	$z = .03$ ($p = .98$)	$z = .24$ ($p = .81$)

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However, when need was not salient, there were only small correlations between need and risk-taking. This result suggests teams might choose preferred strategies when need salience is low. Some evidence suggests that among individuals, personality differences for risk-relevant traits (e.g., impulsivity, sensation-seeking, and self-control) only explain variance in risk-sensitive decision-making in conditions of low need (Mishra & Lalumière, 2010). Football teams may similarly have stable "personalities" that manifest in persistent run or pass orientations. These results further highlight the importance of need salience in risk-sensitive decision-making.

The results of this study should not be particularly surprising to anyone familiar with football. However, intuitive results should not be interpreted as unimportant. In the same way the "Power-O" remains a staple running play in modern playbooks (despite being introduced in the early 1900s), establishing the external validity of risk-sensitivity theory outside of experimental settings provides important empirical value. Future research should examine motivations behind less intuitive risk-related football behaviors (e.g., the typical willingness to go for a two-point conversion after scoring a touchdown rather than the seemingly less risky option of going for an extra point; decisions to run an offensive play on fourth down rather than punt). Regardless, the current results provide strong further evidence in support of risk-sensitivity theory.

Many decision-making studies take place in what Simon (1956, 1973) termed "small worlds"—perfectly consistent environments of decision-making where all decision options and outcomes are known. Previous studies of risk-sensitivity among individuals have exclusively examined decision-making in only these "small worlds", limiting external validity and generalizability. Examination of team decision-making in a highly competitive, highly salient real-world environment allows for a more generalizable demonstration of risk-sensitivity.

A key problem with many naturalistic datasets is the inability to pinpoint sources of behavior given multiple independent sources of variation. We demonstrated risk-sensitivity in a relatively closed system, offering some defense against such criticisms. NFL and NCAA teams only play games against teams in their respective leagues. Independent governing bodies that have no association with any individual team referee the games. Any environmental competitive imbalances are shared among all parties (e.g., poor weather conditions). The number of possible behaviors in any given situation is constrained by the sport itself. These conditions allowed us to examine decision-making in a naturalistic environment that necessarily constrains degrees of freedom.

The results of all three studies contradict predictions that would be made by such maximizing theories of decision-making as expected utility theory (EUT). EUT posits that people seek to maximize utility in all decisions, where utility is broadly defined as a measure of happiness, gratification, or satisfaction derived from a behavior (Friedman & Savage, 1952). EUT would thus predict that football teams would seek to gain as many yards as possible for each play. However, if teams were solely motivated to gain as many yards as possible, teams would invariably pass in every situation: The mean gain of passing was higher than it was for running in both the NFL and the NCAA (although this difference was not significant in the 2012 NFL season). However, teams still chose to run the ball more frequently in low need situations and increased the proportion of their passes as need levels increased. These behaviors indicate variable risk-propensity based on need as predicted by risk-sensitivity theory, rather than consistent utility maximization on a per-play basis. It is worth noting, however, that one could argue that teams are still utility-maximizing if their frame of reference is to win games, rather than to gain yards on a play-by-play basis.

One might argue that the results of these studies could be just as easily (or perhaps be better explained) by prospect theory. Prospect theory posits that actors make decisions based on a reference point and calculate utility around these reference points to guide decision-making (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981). When decision-makers face potential losses, they tend to be risk-prone, and when decision-makers face potential gains, they tend to be risk-averse. Attaining first downs and outscoring opponents could each be seen as key reference points, with the implication that teams calculate the expected utility of passing or running around these anchors.

A key virtue of risk-sensitivity theory as an explanatory framework over prospect theory in explaining our results derives from the simplicity of risk-sensitivity mechanisms. Risk-sensitive decision-making appears to be a product of the application of a simple heuristic reflecting bounded rationality (Mishra, 2014). Bounded rationality dictates that decision-makers necessarily have limited time and cognitive capacity to make decisions, and therefore apply simple heuristic rules based on simple and robust perceptual inputs (e.g., Gigerenzer & Gaissmaier, 2011; Gigerenzer, Todd, & the ABC Research Group, 1999; Todd & Gigerenzer, 2000, 2012). In football, risk-sensitivity involves the application of two simple rules: Choose options that meet one's needs (i.e., elevate risk-taking when in a situation of high need), and anchor on one's most salient need (i.e., in football, yards-to-down, or points-to-parity, depending on circumstance).

In contrast, evaluations consistent with prospect theory would necessarily involve more complicated cognitive processes designed to maximize utility (i.e., editing, evaluating, and ranking the outcomes of all possible decisions; Kahneman & Tversky, 1979). Such processes would be impossible in circumstances involving decision-making under uncertainty (i.e., prospect theory requires "unbounded" rationality), as well as situations that involve strict time constraints (as is necessarily the case in timed football games). Put another way, prospect theory requires "unbounded" cognition, which is an ill fit to an environment involving quick decisions under constraint (Gigerenzer & Gaissmaier, 2011). The complexity of the application of evaluations consistent with prospect theory would further increase in situations involving multiple reference points (as is the case in football). Differences between risk theories are largely centered around different explication of cognitive mechanisms. Understanding these differences in team context requires experimental evidence beyond the scope of this paper (but provides guidance for future research). For a more comprehensive review

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of the similarities and differences between prospect theory and risk-sensitivity theory, see Mishra and Fiddick (2012) and Mishra (2014).

LIMITATIONS

The current study has limitations that provide directions for future research. Archival data necessitates a trade-off of internal validity for greater external validity. Furthermore, although we have relatively higher external validity in this study compared with other studies of risk-sensitivity in laboratory settings, our sample remains limited, in that it consisted only of plays by a limited number of teams: 32 in the NFL and 75 in the NCAA. However, our sample size of plays was extremely large, and we replicated our findings across two football leagues with different players, game cultures, and incentives.

Both run and pass plays in the NCAA appeared to reflect higher variance in yards gained compared with run and pass plays in the NFL. There are several possible reasons for this observation. First, there are a greater number of NCAA Division I teams, and these teams have much larger rosters. The 127 NCAA Division I teams are made up of rosters of over 85 players, while the NFL has only 32 teams with 53-player rosters. The larger NCAA teams likely drive higher variance in play outcomes by having more players involved with much greater variance in skill levels. The overall quality of the players in the NFL is uniformly higher than in the NCAA. NFL rosters are crafted from elite college players drafted in previous years. Further research should examine the consequences of variance differences within and between populations.

Our sample consisted only of decision-making by men. Very few women play football in the NFL or the NCAA, and there is only one woman who is involved as a play-caller, strategist, or coach (Jennifer Welter was the first woman to be hired as an assistant coach in the NFL in 2015). A large body of evidence shows that men exhibit consistently higher risk-taking than women in most domains (reviewed in Byrnes, Miller, & Schafer, 1999) suggesting that our baseline level of risk-taking in this sample may have been relatively higher than if both men and women were involved. However, previous laboratory studies examining risk-sensitivity have shown no significant gender differences. Rather, both men and women appear to be acutely sensitive to conditions of need and adjust levels of risk-taking accordingly (e.g., Mishra & Lalumière, 2010). Further research is required to examine whether women are similarly as risk-sensitive as men in team contexts.

Football games are played in a zero-sum scenario involving two competing teams. Results cannot be generalized to situations where more than two parties are involved nor can it be generalized to scenarios where decision-makers have the potential to collaborate and create emergent value through their individual-level decisions. Still, our results contribute growing research demonstrating the relevance of risk-sensitivity across decision problems that manifest in multiple domains and contexts (i.e., social, financial, and ethical; Ermer et al., 2008; Hill & Buss, 2010; Mishra et al., 2015; Mishra et al., 2014; Mishra & Fiddick, 2012; Mishra et al., 2012; Wang, 2002). Furthermore, consistently large effect sizes for risk-sensitivity have been demonstrated here and in other studies. Further research in other naturalistic settings is necessary to understand the scope and explanatory power of risk-sensitivity theory (as well as its boundary conditions). For example, it would be interesting to examine differences in risk-sensitivity within seasons (e.g., do teams get more risk-sensitive as the season nears its end?).

Finally, the present studies do not elucidate proximate-level mechanisms that lead to risk-sensitive decisions in groups. Experimental research is needed to shed light on the specific proximate-level mechanisms involved in group decision-making under risk (e.g., how sensitive or aware are specific decision-makers to levels of need?). Such investigations would also clarify differences between risk models (e.g., risk-sensitivity versus prospect theory). Future research could also elucidate implications of non-normally distributed risk curves, especially among different teams (i.e., are there stable "individual differences" in team outcomes and behavioral tendencies?).

CONCLUSION

The results of three studies demonstrate that football teams make risk-sensitive decisions sensitive to two need levels: yards-to-down, and points-to-parity. These findings replicate and extend previous research demonstrating that individuals make risk-sensitive decisions based on conditions of need. Of particular note, we demonstrated emergent risk-sensitivity in a naturalistic, organizational context.

An understanding of the psychological processes underlying risk-sensitive decision-making has important implications for those in more general competitive settings, as well as coordinated group activities in decision-making under risk. This knowledge may be used to broadly understand and improve organizational decision-making, especially decisions involving risk under conditions of need or goal states. Almost every individual-level or organizational-level decision is made under consideration of multiple needs, and thus understanding how people prioritize multiple reference points of need provides insight into shaping and understanding organizational decision-making.

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