

Turning the Tide: Big Plays and Psychological Momentum in the NFL

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Abstract

In this paper, we investigated one often-discussed form of psychological momentum in the NFL – whether a team’s offense performs better after their teammates make a big defensive play. We compared drives preceded by a big defensive play (BD drives) and those that weren’t (NBD drives) on three dependent variables: the result of the first play after the change of possession, the success or not of the first set of downs, and the points scored on the drive. Possible confounding variables that may change teams’ strategy were accounted for to provide a symmetrical comparison between BD and NBD drives. For each dependent variable, we compared the counts of specific outcomes between BD and NBD drives. Some differences were observed, but Pearson’s Chi Square tests showed no significant association between big defensive plays and subsequent offensive performance. Therefore, despite popular belief to the contrary, we found no evidence to support a transfer of psychological momentum from a team’s defense to its offense.

1 Introduction

In the first week of the 2011 NFL season, Washington Redskins linebacker Ryan Kerrigan intercepted a second-quarter pass from New York Giants quarterback Eli Manning and ran it in for a touchdown. This interception had the obvious benefit of a 14-point swing – it robbed the Giants of 7 points and gave the Redskins 7 points. However, many in the media pointed to an additional effect of this “pick six”. As the Redskins’ website proclaimed later that day, “Kerrigan’s Interception Changed Momentum” [1]. This belief in “psychological momentum” – the idea that a big play can motivate teams to perform better during subsequent plays – is a prevalent thought. In post-game analyses, NFL coaches, players, fans, and the media all point to interceptions [2], fumbles [3,4], 4th down stops [5], and other big defensive plays [6,7] that “turned the tide” of the game. But does psychological momentum truly exist, or is it simply a “cognitive illusion”? And, if it does exist, can it be “transferred” from a team’s defense to its offense, which had nothing to do with the turnover? In this paper, we investigate the effect of psychological momentum through the analysis of NFL teams’ offensive performances after big defensive plays.

2 Background

Psychological momentum is defined by the Oxford Dictionary of Sports Science & Medicine as “the positive or negative change in cognition, affect, physiology, and behavior caused by an event or series

of events that affects either the perceptions of the competitors or, perhaps, the quality of performance and the outcome of the competition” [8]. As this definition attests, events on the field certainly change the attitudes of athletes, but it is unclear whether these result in changes in performance. Taylor and Demick constructed a multidimensional model of momentum in sports – the “Momentum Chain” – that posits the factors influencing whether an athlete’s perception of momentum translates into a change in his performance [9]. These are organized into 6 steps that they theorize all must occur in sequence for a momentum to have a noticeable effect.

- 1) Precipitating event or events
- 2) Change in cognition, affect, and physiology
- 3) Change in behavior
- 4) Change in performance consistent with the above changes
- 5) A continuous and opposing change in the previous factors on the part of the opponent (for sports with head-to-head competition)
- 6) A resultant change in the immediate outcome

These factors are highly individualized – their impact on a player’s performance depends on his experience, self-efficacy (“a situation-specific form of self-confidence” [10]), perceptions of control, and attitude.

Researchers have quantitatively investigated psychological momentum in many sports, but there is still conflicting evidence as to whether precipitating events translate into observable changes in performance. In an analysis of Wimbledon tennis matches between 1992 and 1995, Klaassen and Magnus did find that there were small positive and negative effects of momentum [11]. Another study by Terry Appleby in 2012 found evidence for psychological momentum in hockey [12,13]. According to his analysis, a fight increases the momentum (as defined by the number of shots on goal per second) of at least one of the teams involved 76% of the time. Other researchers have found no effect of psychological momentum. The seminal study of “the hot hand” in basketball was performed in 1985 by Gilovich, Vallone, and Tversky [14]. They found that while players and fans believed “a player’s chance of hitting a shot are greater following a hit than following a miss on the previous shot,” neither a statistical analysis of two NBA teams’ shooting records nor a controlled experiment with collegiate basketball players lent support to this idea. S. Christian Albright performed a similar study for hot and cold hitting streaks in baseball, finding that the behavior of all MLB players as a whole did not differ significantly from a model of randomness [15]. Therefore, he also discounted the average effect of psychological momentum.

Research into psychological momentum in the NFL has also shown evidence for and against momentum. In his 2006 paper on 4th down decisions, Romer looked at both “bad” and “good” plays and their effect on the three subsequent plays [16]. Bad plays were defined as changes in possession where the ball advanced less than ten yards, and good plays were touchdowns. Romer found that there was no significant momentum effect; rather, there was a slight effect of “counter-momentum”. As Romer stated, “From the situation immediate following a bad play to the next, the team that lost possession does somewhat better than average” (pp. 358). In November 2011, Football Freakonomics produced a 4-minute video on momentum in football [17]. While the video gave a number of example statistics that supported both momentum and counter-momentum within a team’s offense, it concluded that momentum is likely a cognitive illusion with effects that are felt more than they actually exist. This analysis differs from ours in that it did not look at the “transfer” of psychological momentum from a team’s defense to its offense, nor did it test for statistical significance. On the

Advanced NFL Stats Community website, Andy Steiner investigated this transfer of psychological momentum, in investigating how much more likely an intercepting team was to score afterwards [18]. His analysis of the 2002-2009 NFL seasons suggests that there was no positive effect of momentum, but he did not test for statistical significance either.

3 Methods

Our overall data set consists of all 473,621 plays run in the 2,921 games during the 2000-2010 NFL seasons. This data is publicly available from ArmchairAnalysis.com. From this data, we gathered information about each drive (69,330 total), starting with the first play after a change of possession. We are interested in two different categories of drives: those that followed a big defensive play (“BD drives”), and those that did not (“NBD drives”). We identified six types of big defensive plays:

- 1) Interception
- 2) Fumble recovered by the defense
- 3) 4th down stop (turnover on downs)
- 4) Safety
- 5) Blocked field goal or punt
- 6) Muffed punt recovered by the kicking team

If a turnover resulted in a defensive touchdown, we removed this play from our analyses. We are interested in the transfer of momentum between a given team’s defense and offense on the drive following a big defensive play. When a defensive touchdown is scored, the offense that gave up the turnover regains possession.

There are a number of confounding variables that anecdotally change a team’s strategy and may affect an offense’s success. These factors include:

- 1) The score differential (offense-defense)
- 2) The time left in the game
- 3) The starting yard line of the drive (measured as yards from own goal)

One method used by researchers to remove the effects of these confounding variables is to take portions of the game data where strategy is assumed to be constant [18,19]. We utilized a similar method, and only considered first-quarter drives with a score differential of less than 10 points. This accounts for the effects of the first two confounding variables; however, strategy and potential performance outcomes still change with starting yard line within the first quarter. To ensure a symmetrical comparison of BD and NBD drives with respect to starting yard line, both the BD and NBD data subsets were divided into 10 groups of evenly spaced 10-yard increments (e.g. 0-10, 11-20, etc.). For the statistical analysis of psychological momentum, equal numbers of samples were randomly drawn from each group, ensuring that we analyzed the same number of BD and NBD plays from each yard line range. The resultant final data set for analysis comprised 3,204 total changes of possession, split evenly between BD and NBD drives. To ensure that the random draws of data did not have a significant effect on the overall findings, 1,000 bootstrapped samples were generated.

To account for effects of psychological momentum over a number of time horizons, we selected three dependent variables (DV) for our analyses. Increasing in time, these are:

- 1) The result of the first play after a change of possession
- 2) The result of the first set of downs after a change of possession

- 3) The result of the entire drive after a change of possession, as measured by the points scored on that drive

These DVs are designed to be unaffected by psychological momentum within an offense, which has been seen in previous studies [17]. Within the first two DVs the offense has run at most 4 plays, a short time for offensive momentum to build up. Furthermore, if there are any “big plays” greater than 10 yards in the first set of downs, any potential momentum from these will not affect the first two DVs. The third DV is not influenced by offensive momentum because it does not care how a team scored – if they ground it out with short plays or successfully gambled on long plays – but rather whether or not they eventually scored. A long kick or punt return may have an effect on the offense’s performance, but special teams’ effect on momentum is left for future studies.

Statistical analyses on the effect of a big defensive play on the DVs were performed using contingency tables. The possible outcomes for each of the three DVs are identified below:

First play	First set of downs	Points on drive
1) Safety	1) Set of downs resulted in a first down or score (successful)	1) The opposing defense scored a touchdown
2) Loss of possession	2) Set of downs did not result in a first down or score (unsuccessful)	2) The opposing defense scored a safety
3) Loss of yardage		3) No points were scored on the drive (stalled drive or turnover)
4) 0-3 yards gained		4) Field goal
5) 4-6 yards gained		5) Touchdown
6) 7-9 yards gained		
7) 10-30 yards gained		
8) 30-50 yards gained		
9) 50+ yards gained		
10) Touchdown		

For the analysis of a DV, the counts of each outcome in the final data set were tallied. The resultant contingency tables were analyzed for a significant association between the presence of a preceding big defensive play and the outcomes of interest using Pearson’s Chi Square Test of Independence.

4 Results

First Play After Change of Possession

Table 1 below shows the average counts (\pm standard deviation) of each of the outcomes considered for the result of the first play of a new drive. The first play of BD drives show higher counts of gains of 50+ yards, and also a slight increase in the number of plays that result in negative yardage. Additionally, plays succeeding a big defensive play show a decrease in turnovers as compared to NBD drives. However, these differences were not statistically significant at the $\alpha=0.05$ level by Pearson’s Chi Square test ($p = 0.2867 \pm 0.0547$). If psychological momentum after big defensive plays is causing a change in performance that results in more +50-yard plays and fewer turnovers on the first play, the difference is not large enough to be discounted from random chance. Note that there is considerable variation based on the standard deviations of each of the counts, indicating some dependence on the random selection of plays required to match starting yard lines. However, the bootstrapping method used in this analysis ensures that the results are not dominated by a small set of atypical cases.

Table 1. Contingency table showing counts of outcomes of the first play of a drive based on BD and NBD classifications. Numbers shown are the mean counts +/- standard deviation.

Outcome	Big Defensive Play	Normal Play
Gain of 0-3 yards	626.911 ± 89.31	639.818 ± 283.20
Gain of 4-6 yards	307.195 ± 51.61	281.862 ± 177.79
Gain of 7-9 yards	163.195 ± 38.28	171.035 ± 125.79
Gain of 10-30 yards	215.369 ± 30.37	230.625 ± 141.55
Gain of 30-50 Yards	12.089 ± 0.22	19.417 ± 18.18
Gain of 50+ yards	8.000 ± 0.00	4.634 ± 4.70
Touchdown	32.501 ± 20.93	27.456 ± 8.25
Negative Yards	122.056 ± 31.66	105.22 ± 83.75
Loss of Possession	18.795 ± 6.73	27.347 ± 16.75
Safety	1.000 ± 0.00	0.493 ± 0.53

First Set of Downs After Change of Possession

Similarly, Table 2 shows the contingency table for the result of the first set of downs after a change of possession. Having a successful set of downs, judged by either achieving a first down or scoring, was slightly more likely after a big defensive play. However, this was not significant as determined by the Chi Square test ($p = 0.423 \pm 0.0775$).

Table 2. Contingency table showing counts of outcomes of the first set of downs of a drive based on BD and NBD classifications. Numbers shown are the mean counts ± standard deviation.

Outcome	Big Defensive Play	Normal Play
Successful	1148.792 ± 51.25	1123.212 ± 245.33
Unsuccessful	450.750 ± 50.50	471.805 ± 245.77

Points on Drive

Table 3 below shows the contingency table associated with the outcome of the drive, quantified as the points scored on that drive. BD drives show slightly higher proportions of defensive safeties, field goals, and touchdowns; and a lower proportion of defensive touchdowns. However, once again this potential association is not significant by Pearson's Chi Square test ($p = 0.313 \pm 0.0543$).

Table 3. Contingency table showing counts of outcomes of a drive based on BD and NBD classifications. Numbers shown are the mean counts ± standard deviation.

Outcome	Big Defensive Play	Normal Play
Defensive Touchdown	9.204 ± 1.37	13.835 ± 11.67
Defensive Safety	6.00 ± 2.20	2.204 ± 2.11
No Points Scored	846.667 ± 64.46	875.409 ± 277.00
Field Goal	311.691 ± 91.16	296.938 ± 141.69
Touchdown	428.438 ± 95.32	413.614 ± 190.11

5 Discussion

While there were differences in the frequencies of outcomes between BD and NBD plays, sets of downs, and drives; these were not sufficiently different to find a statistically significant association. This implies that any effects of psychological momentum being transferred from a team's offense to a defense are no greater than random chance. Potential reasons for this result can be understood through Taylor and Demick's Momentum Chain [9]. For a precipitating event to have an effect on an individual's performance, a number of factors and internal attitudes must line up perfectly. This is not to say that psychological momentum does not exist at all. It can certainly occur in an NFL game – a running back who loses a fumble can start paying attention to his ball security and not lose another fumble. However, there are three factors that we believe may prevent a big defensive play from changing an offensive's subsequent performance.

For noticeable outcomes of psychological momentum to be visible on the field, multiple offensive players must complete the full Momentum Chain and alter their performance. Granted, there are specific players whose individual performance is more important to the team, such as the quarterback. A future analysis of quarterback-specific metrics might show an influence of psychological momentum. However, if the center, right guard, wide receiver, and tight end change their performance, there may be no visible effect.

The players on offense also had nothing to do with the prior big defensive play; they were on the sideline when it happened (the exception is utility players like Patriots wide receiver/defensive back Julian Edlemon). While the offense will undoubtedly be happy with their teammates' performance, they may not have additional encouragement to do better than they otherwise would have. Furthermore, the opposing defense whose team just gave up the ball may be frustrated and angry with their teammates, but they may not feel like there is any change they're able to make. They weren't the ones who made the error! Therefore, the players on either side of the ball may not feel that they have control over the performance of their team's other unit who created the precipitating event.

If enough offensive players *do* change their performance after a big defensive play, the effects of psychological momentum may still not be observable. As Taylor and Demick note, in head-to-head sports the Momentum Chain requires "a continuous and opposing change in the previous factors on the part of the opponent." In other words, the offense must undergo positive momentum and the opposing defense must undergo negative momentum to see a change in performance. If, like the offense, the opposing defense also increases their performance after a big defensive play, no effects of momentum will be seen.

6 Conclusion

Psychological momentum in sports remains an elusive concept with continual questions regarding its existence (or lack thereof) and effect on the game. In this paper, we have investigated one form of psychological momentum in the NFL – whether a team's offense performs better after their teammates make a big defensive play. Our results of offensive performance, as quantified by three different dependent variables, indicate that a big defensive play does not appear to improve the performance of the offense on the subsequent drive. Even with this evidence, the debate between fans, players, coaches, writers, and analysts about the presence and effects of psychological momentum in the NFL will likely continue for the foreseeable future.

Acknowledgements

We would like to thank Armchair Analysis.com for freely and openly providing the huge wealth of NFL play-by-play data upon which this research has been based. We'd also like to thank Dr. Jaime Mateus, for his advice on the statistical analysis of this data.

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