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short communication

The "three-point shooting paradox": An artifact or a real phenomenon? Replication with large-scale National Basketball Association (NBA) data

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ABSTRACT

Psychological science is often being criticized for failing to reproduce some of its findings. Considering this critique, Iso-Ahola (2024) argues that it is important to establish a demarcation line between artifact and a real phenomenon, recognizing that psychological phenomena are not constant particles that can be definitively declared to exist or not exist upon discovery. In this brief paper, we utilize newly available large-scale data to replicate a finding by Lidor et al. (2022), who reported a psychological effect wherein professional basketball players shoot better under tight defensive pressure rather than free of it. The current analysis of 781,663 three-point shots over 11 seasons in NBA (as compared to 382 shots taken by 12 players during 12 games in the original study) failed to support the idea of the three-point shooting paradox but instead strongly supports the commonsense hypothesis that tight defense hinders shooting performance.

1. Introduction

Endeavors to promote evidence-based practices in psychology depend upon research findings to be valid, reliable, and generalizable (Steiner et al., 2019). Replicability is defined as the ability to obtain similar findings across studies that aim to answer the same question but collecting and using their own data and methodology (i.e., verification). Replication is deemed as a bedrock of science and has long been imperative for establishing credible results that are generalizable to some current or future populations (Simons, 2014). In its essence, replicability underscores the principle that scientific knowledge should not be based on sporadic occurrences (Finkel et al., 2017).

Gomez et al. (2010) identified three types of verification: re-analysis, replication, and reproduction. Re-analysis involves using data from a previously conducted study to ensure that no errors were made during the data analysis phase and to determine whether similar findings can be obtained using the same data but with different analysis techniques. Replication verifies that the observed findings are stable enough to be discovered more than once, including in additional populations, by using the same methods as the baseline study. Reproduction, on the other hand, ensures that the findings are not attributable to the method itself. This form of verification uses different methodological tools to test the same theoretical question as the baseline study, thereby validating that the original findings are not artifactual (i.e., a product of apparatus). An important notion here is that there is no accepted clear-cut criterion to determine whether one study replicates another. Terms such as direct, exact, literal, operational, and conceptual replication have been introduced to describe the similarities and discrepancies in respect to the original study, with conceptual replication corresponding to the previously mentioned concept of reproduction (Schmidt, 2009).

2. Effects that have failed verification

Several allegedly notable psychological effects in the domain of sports have failed the test of replication or in some cases were dismissed by alternative explanations. Berger and Pope (2011) reported that basketball teams behind by a point at halftime actually win more often than teams ahead by one point. This surprising "barely losing leads to winning" effect was explained through motivation and effort that are being boosted when teams at halftime find themselves marginally below their goal. Namely, people who are slightly behind in a competition may be more motivated than people who are slightly ahead. Klein Teeselink (2023) replicated and extended Berger and Pope's (2011) analysis by including Australian football, American football, and rugby in addition to basketball. Klein Teeselink found no supportive evidence for the effect in these newly analyzed sports, nor in basketball outside the original sample. Moreover, Merritt and Clauset (2014) proposed that an

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additional mechanism might contribute to the "barely losing leads to winning" effect, suggesting that basketball teams substitute stronger players with weaker ones when leading to allow key players to rest, minimize injuries, or manage personal fouls. In this manner, a team might exhibit weaker performance when leading and stronger performance when trailing, not only due to shifts in motivation and effort but also due to personnel changes (i.e., alternative explanation).

Apesteguia and PalaciosHuerta (2010) collected data from 129 penalty shootouts and found that the first kicking team won in 60.5 % of the cases. This indicates that, despite an initial equal probability of winning, the team shooting first had a significant 21 percentage point advantage over the team shooting second. The authors identified the additional pressure that the team shooting first exerts when scoring and taking the lead as the factor undermining the performance of second kickers – a phenomenon denoted "first-mover advantage". Despite a wide media attention[1] and hundreds of academic citations, replication and extension to 540 shootouts by Kocher et al. (2012) failed to detect "first-mover advantage" effect outside the original cohort. A recent analysis of 663 penalty shootouts by Santos (2023) reaffirmed this null result.

Another illustrious example of initial constructs challenged by later research is the hot hand (momentum) paper by Gilovich et al. (1985) who found no evidence for streakiness in the shooting of nine National Basketball Association (NBA) players. The authors concluded that laypeople, fans, coaches, and players themselves who all showed strong belief in success breeds success effect were susceptible to cognitive bias. Subsequent and more elaborate analysis of the hot hand in sports and in basketball in particular undermined Gilovich's et al. original conclusion (Csapo et al., 2015; Miller & Sanjurjo, 2021; Raab et al., 2012; Weimer et al., 2023). Morgulev (2023) identified the absence of a well-defined theoretical framework in momentum research as one of the reasons for the inconsistent results.

The academic discourses mentioned here underscore the importance of verification by addressing similar theoretical questions with novel methodological tools applied to diverse populations.

3. The three-point shooting paradox

Lidor et al. (2022) conducted a two-phase study on three-point shooting in basketball under pressure versus no-pressure game situations. First, they examined coaches and players perceptions regarding shooting three-point shots and revealed as expected that both players and coaches believed the success rate to be higher when the shot is taken free of defensive pressure. Next, the authors analyzed data from the Israeli Basketball Super League and paradoxically discovered shooting success rate under tight defense to be higher than in shots taken in free of defense situations.

The authors build upon Moran (2012) who argued that thinking too much about what one is doing, or trying to exert conscious control over actions that are normally performed automatically, has the potential to cause one's skills to unravel. The authors incorporated Kahneman's (2011) two-system approach to explain how skilled performers who played competitive basketball at the highest level were able to act automatically when aiming at the basket under tight defensive pressure. Namely, using System 1 in Kahneman's model – an intuitive and automatic way of thinking that allowed players to successfully ignore external distractions they had to face.

Adversely, in free of pressure conditions, players found themselves having some time to think and to prepare. They might even consider the negative outcome of missing the shot. In this situation a more deliberate and reflective way of thinking – System 2 – is being used. This way of thinking can create internal distractions, such as negative and irrelevant thoughts, unpleasant emotions, and anxiety, all of which apparently associated with a detrimental mode of conscious control over the shot execution.

In the Limitations sections the authors emphasized that their conclusion is based on a sample of 382 shots. Therefore, future studies should address data from several seasons and at different levels of competition, as an analysis of a larger sample may strengthen the findings.

In a recent update to the official NBA Stats Home platform, data regarding shots' defensive pressure have become publicly available.[2] The NBA divided all shots started from the 2013-14 season to four categories by the closest defender distance range: very tight (0–2 feet), tight (2–4 feet), open (4–6), and wide open (6+ feet). This development allows us to respond to the call made by Lidor et al. (2022) and to examine the association between defensive pressure and three-point shooting percentage using large-scale NBA data and thus to answer the question whether the three-point shooting paradox is a methodological artifact or a real phenomenon.

4. Methods

We retrieved team-level annual data from 2013 to 2023 regular seasons in NBA. We followed the original study by focusing on three-point shots taken by point guards and shooting guards. Players in these positions are expected to demonstrate solid three-point shooting ability and account for the majority of three-point attempts in the game.

The operationalization of the pressure variable differs between the current study and the original one. While the NBA platform relied on objective distance measures, Lidor et al. (2022) utilized expert evaluations. Specifically, experienced coaches assessed whether the defensive player guarding the shooter was far enough to avoid interference with the shot, whether no other defensive player was in a position to pressure the shooter, and whether the shooter had enough space to execute the shot using their natural shooting style.

Although the current study follows the same logic of defenders' proximity and their ability to hinder the shot attempt, it cannot be considered a direct replication under Schmidt's (2009) criteria, given that our analysis is based on objective measurements rather than the subjective evaluations of coaches used by Lidor et al. Thus, the current study may be more accurately described as a conceptual replication or reproduction, consistent with the terminology of Gomez et al. (2010).

In Table 1, we present some descriptive statistics for the three-point attempts in our sample.

We learn from Table 1 that our data consists of 781,663 three-point

Table 1
Descriptive statistics of guards' three-point attempts by closest defender distance range.

	Very tight (0–2 feet)	Tight (2–4 feet)	Open (4–6 feet)	Wide open (6+ feet)	Total
Three-point attempts by defense pressure	7031	88,156	295,477	390,999	781,663
Per team per season average	21.31	267.14	895.38	1184.85	2368.58
Minimum	1	88	348	518	
Maximum	84	688	1613	1864	
SD	13.28	97.96	231.06	263.72	

[1] https://www.nytimes.com/2017/05/10/sports/soccer/uefa-tinkers-with-penalty-shootouts-aiming-at-first-kick-advantage.html.

[2] https://www.nba.com/stats/teams/shots-closest-defender.

attempts taken by shooting guards and point guards over 11 regular seasons. The official league platform divides this sample into four categories: 7031 and 88,156 shots were taken under very tight and tight defense respectively. Whereas the majority of shots were taken in open and wide-open conditions: 295,477 and 390,999 respectively. We can see that even at this large-scale analysis there is a problem with the very tight defense category. Dividing 7031 attempts into 11 seasons per 30 teams boils down to an annual average of 21.31 very tight defense shots per team per season in our sample. We will respond to this threat by focusing on tight defense shots versus open and wide-open shots when looking for statistically significant differences in three-point shooting percentage.

5. Results

We begin with an 11-fold replication of Lidor et al.'s analysis by presenting three-point shooting percentages under very tight, tight, open, and wide-open defensive conditions over an 11-season period in the NBA.

Results in Table 2 are clear and unanimous – the tighter the defense, the worse the shooting. We conducted one-way ANOVA for each season as well as for the entire period combined. Post hoc comparisons using Tukey HSD test indicate that the increase in shooting percentage from the tight defense condition to the open and wide-open defense condition was significant ($p < .05$) in eight out of eleven seasons (bolded in Table 2). In the three remaining seasons the trend remained the same but simply failed to reach statistical significance: from 29.90 % (tight) to 33.40 % (open) in 2014 season ($p = .130$); from 30.70 % (tight) to 35.03 % (open) in 2017 season ($p = .083$); and from 29.07 % (tight) to 34.63 % (open) in 2022 season ($p = .055$).

To better illustrate the significance of the obtained results, Table 3 presents three-point shooting percentages alongside the 99 % confidence intervals over the entire period.

To conclude, we look at the eta-squared values (η2) presented in Table 2. The effect sizes observed are large across all seasons (ranged from .23 to .58), with defense conditions accounting for 37 % of the variance in shooting percentage over the entire period.

6. Discussion

Iso-Ahola (2024) wonders whether a psychological effect have to be experienced always, everywhere, and by everyone, or just sometimes, somewhere, and by some people in order to constitute a psychological phenomenon. Additionally, Iso-Ahola emphasizes that a psychological phenomenon is not a constant that is replicable in and generalizable to all contexts among all people, but instead, varies as a function of where, when, how, and in whom the phenomenon is observed. While acknowledging that replications can either add to or subtract from a theorized pattern's "track record" and are useful as they provide new information on phenomena's boundary conditions, Iso-Ahola puts forward that even if a verification study failed to reproduce the original finding, it does not mean the phenomenon cannot or does not exist.

And yet the current failure to verify Lidor et al. (2022) shooting paradox seems to be less related to the context dependency and variability in behavioral response to similar stimulus that is inherent in psychological phenomena but to the insufficient sample of the original study. Lidor et al. divided the 382 three-point shots into 145 attempts taken without defensive pressure and 233 attempts taken under defensive pressure (with no agreement reached on the classification of the four remaining shots). This implies that, on average, the original analysis relied on approximately 12 no-pressure shots taken by 12 players. Obviously, such data are highly sensitive to even a single outlier or a few missed attempts. Therefore, we kindly advocate for a more cautious approach when dealing with samples of this magnitude.

As for the current data, the findings are consistent and conclusive across all three-point shots taken by guards over 11 regular NBA seasons (more than 10,000 games). The conclusion is intuitive and straightforward: tight defense hinders shooting performance (see Table 3). Our objective large-scale data show that the three-point shooting paradox does not exist.

Table 3
Three-point shooting percentage and 99 % confidence intervals under different defense conditions over an 11-season period in the NBA.

	Mean	Std. Error	Lower bound	Upper bound
Very tight	25.13	.369	24.18	26.09
Tight	29.17	.369	28.22	30.12
Open	34.56	.369	33.60	35.51
Wide open	38.57	.369	37.62	39.53

CRediT authorship contribution statement

Elia Morgulev: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 2
Three-point shooting percentage under different defense conditions in the NBA.

	Very tight		Tight		Open		Wide open		Total		*F* (3,116)	*p*	*η2*
	%	n	%	n	%	n	%	n	%	N			
2013	**23.43**	**782**	**29.27**	**6475**	**34.87**	**18,881**	**39.07**	**26,208**	**36.22**	**52,346**	**53.06**	**.00**	**.58**
2014	22.63	812	29.90	7046	33.40	19,570	38.17	27,160	35.26	54,588	33.74	.00	.47
2015	**22.37**	**890**	**28.27**	**6963**	**34.17**	**20,959**	**38.47**	**29,939**	**35.60**	**58,751**	**48.43**	**.00**	**.56**
2016	**26.20**	**1058**	**28.73**	**7672**	**35.17**	**23,085**	**38.33**	**33,932**	**35.98**	**65,747**	**43.67**	**.00**	**.53**
2017	22.20	625	30.70	7701	35.03	25,929	38.83	35,954	36.44	70,209	31.25	.00	.45
2018	**25.03**	**697**	**28.50**	**8137**	**33.90**	**28,377**	**38.00**	**41,184**	**35.49**	**78,395**	**25.68**	**.00**	**.40**
2019	**27.93**	**557**	**29.63**	**8703**	**34.50**	**28,645**	**38.37**	**33,806**	**35.80**	**71,711**	**14.56**	**.00**	**.27**
2020	**29.03**	**491**	**29.87**	**8353**	**35.47**	**29,854**	**39.10**	**35,894**	**36.67**	**74,592**	**16.28**	**.00**	**.23**
2021	**28.00**	**399**	**28.17**	**9563**	**34.10**	**35,130**	**38.20**	**41,054**	**35.37**	**86,146**	**13.97**	**.00**	**.27**
2022	26.10	321	29.07	8652	34.63	33,629	38.63	41,253	36.07	83,855	13.36	.00	.26
2023	**23.60**	**399**	**28.83**	**8891**	**34.93**	**31,418**	**39.20**	**44,615**	**36.58**	**85,323**	**18.70**	**.00**	**.33**
	Very tight		Tight		Open		Wide open		Total		*F* (3,1316)	*p*	*η2*
	%	n	%	n	%	n	%	n	%	N			
Entire period	**25.1**	**7031**	**29.1**	**88,156**	**34.5**	**295,477**	**38.5**	**390,999**	**35.9**	**781,663**	**256.93**	**.00**	**.37**

Data availability

Data will be made available on request.

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Acknowledging the elaborate methodology of the original study, including the dozens of hours spent viewing game recordings, identifying and editing out specific instances of three-point shots, and classifying these cases with the help of four professional coaches. We wish to clarify that the aim of our current work is to promote objective, open, and credible scientific debate through replication and critical examination. This process inevitably involves both scrutiny and critique of prior research; however, it is mandatory for ensuring that scientific claims are robust and open to revision based on new evidence.

References

Apesteguia, J., & Palacios Huerta, I. (2010). Psychological pressure in competitive environments: Evidence from a randomized natural experiment. *The American Economic Review, 100*(5), 2548–2564.

Berger, J., & Pope, D. (2011). Can losing lead to winning? *Management Science, 57*(5), 817–827. .

Csapo, P., Avugos, S., Raab, M., & Bar Eli, M. (2015). The effect of perceived streakiness on the shot-taking behaviour of basketball players. *European Journal of Sport Science, 15*(7), 647–654. .

Finkel, E. J., Eastwick, P. W., & Reis, H. T. (2017). Replicability and other features of a high-quality science: Toward a balanced and empirical approach. *Journal of Personality and Social Psychology, 113*(2), 244.

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology, 17*(3), 295–314.

Gomez, O. S., Juristo, N., & Vegas, S. (2010). Replication, Reproduction and Reanalysis: Three ways for verifying experimental findings. In *International symposium on workshop on replication in empirical software engineering research*. Cape Town: ACM.

Iso-Ahola, S. E. (2024). Science of psychological phenomena and their testing. *American Psychologist. Advance Online Publication*.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Klein Teeselink, B., van den Assem, M. J., & van Dolder, D. (2023). Does losing lead to winning? An empirical analysis for four sports. *Management Science, 69*(1), 513–532. .

Kocher, M. G., Lenz, M. V., & Sutter, M. (2012). Psychological pressure in competitive environments: New evidence from randomized natural experiments. *Management Science, 58*(8), 1585–1591.

Lidor, R., Lipshits, L., Arnon, M., & Bar-Eli, M. (2022). "Don't think, just shoot"–The paradox of shooting three-point shots in basketball. *International Journal of Sport and Exercise Psychology, 20*(6), 1523–1541. .

Merritt, S., & Clauset, A. (2014). Scoring dynamics across professional team sports: Tempo, balance and predictability. *EPJ Data Science, 3*, 4.

Miller, J. B., & Sanjurjo, A. (2021). Is it a fallacy to believe in the hot hand in the NBA three-point contest? *European Economic Review, 138*, Article 103771.

Moran, A. (2012). Thinking in action: Some insights from cognitive sport psychology. *Thinking Skills and Creativity, 7*(2), 85–92.

Morgulev, E. (2023). Streakiness is not a theory: On "momentums"(hot hands) and their underlying mechanisms. *Journal of Economic Psychology, 96*, Article 102627. .

Raab, M., Gula, B., & Gigerenzer, G. (2012). The hot hand exists in volleyball and is used for allocation decisions. *Journal of Experimental Psychology: Applied, 18*(1), 81. .

Santos, R. M. (2023). Effects of psychological pressure on first-mover advantage in competitive environments: Evidence from penalty shootouts. *Contemporary Economic Policy, 41*(2), 354–369. .

Schmidt, S. (2009). Shall we really do it again? The powerful concept of replication is neglected in the social sciences. *Review of General Psychology, 13*(2), 90–100. .

Simons, D. J. (2014). The value of direct replication. *Perspectives on Psychological Science, 9*(1), 76–80.

Steiner, P. M., Wong, V. C., & Anglin, K. (2019). A causal replication framework for designing and assessing replication efforts. *Zeitschrift für Psychologie*.

Weimer, L., Steinert-Threlkeld, Z. C., & Coltin, K. (2023). A causal approach for detecting team-level momentum in NBA games. *Journal of Sports Analytics, 9*(2), 117–132. .