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Mental toughness: state or trait? Context and sporting performance in rugby union, a longitudinal study

Fortaleza mental: ¿Estado o rasgo? Contexto y rendimiento deportivo en el rugby, un estudio longitudinal

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Abstract. Mental toughness is a concept that has been considered a critical feature of sporting success. However, there are still conceptual issues related to its traitness and its relationship with sporting performance that remain unresolved. Consequently, the objective of this research is to contrast empirically whether the eventual changes in MT and its relationships with competition phases and sporting performance can sustain the notion of MT as a state or a trait. A longitudinal study included 12 male Chilean rugby players, aged 18-33 years, which regularly competed at the highest national level. The results indicated that there are no significant differences in mental toughness between the four measurements taken in the study and that the competitive phase did not predict mental toughness properties enduring across contexts and time. In addition, the data showed that mental toughness is an important predictor of relevant behavioural variables and sporting performance.
Keywords: mentally tough, sports psychology, sporting success, rugby.

Resumen. La fortaleza mental es un concepto que ha sido considerado como una característica crítica del éxito deportivo. Sin embargo, aún existen cuestiones conceptuales relacionadas con su naturaleza como rasgo y su relación con el rendimiento deportivo que permanecen sin resolver. Por lo tanto, el objetivo de esta investigación es contrastar empíricamente si los posibles cambios en la fortaleza mental y sus relaciones con las fases de competición y el rendimiento deportivo pueden sustentar la noción de la fortaleza mental como un estado o un rasgo. Un estudio longitudinal incluyó a 12 jugadores de rugby chilenos, de entre 18 y 33 años, que compiten regularmente al más alto nivel nacional. Los resultados indicaron que no hay diferencias significativas en la fortaleza mental entre las cuatro mediciones realizadas en el estudio y que la fase competitiva no predijo las propiedades de la fortaleza mental, las que perduran a lo largo de los contextos y el tiempo. Además, los datos mostraron que la fortaleza mental es un predictor importante de variables de comportamiento relevantes y del rendimiento deportivo.
Palabras clave: fortaleza mental, psicología del deporte, éxito deportivo, rugby.

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Introduction

The pursuit of excellence in sporting performance encompasses the continuing development of physical, technical, tactical, and mental skills. Frequently, millimetres and microseconds are decisive factors in achieving victory. In addition, when athletes of similar physical, technical and tactical ability have reached their optimal potential their success depends on psychological components (Wieser & Thiel, 2014; Zengin & Kirkbir, 2020). According to several authors (Akbar et al., 2024; Jones & Parker, 2017; Putra et al., 2024; Valadez et al., 2024), since the turn of the century mental toughness (MT) has increasingly intrigued researchers, practitioners, coaches and athletes as a construct that captures many of the psychological attributes which help to account for athletes' positive results.

Regarding what MT is, it can be defined as "a state-like psychological resource that is purposeful, flexible, and efficient in nature for the enactment and maintenance of goal directed pursuits" (Gucciardi, 2017, p. 18). In addition, MT can be described as "the ability to achieve personal goals in the face of pressure from a wide range of different stressors" (Bell et al., 2013, p. 281). For some scholars MT is conceptualised as a state (Gucciardi, 2017; Weinberg et al., 2017), others conceive it as a trait (Bell et al., 2013; Hardy et al., 2014), while certain researchers consider that MT is both dynamic in nature and stable (Gucciardi et al., 2015; Gucciardi et al., 2016). According to Endler et al. (1991), "the assessment process must distinguish between the individual's predisposition to have a particular experience or engage in a particular behavior and the individual's actual response in a specific situation" (p. 919). Therefore, a state is a relatively unstable and inconsistent aspect of personality that is changeable over time and across situations (Hanin, 2000). Traits are relatively enduring patterns of thoughts, feelings, and behaviour (Roberts et al., 2006). Collectively, these arguments suggest that to resolve this controversy, empirical evidence should address three aspects of the construct of MT: temporal stability, relationship with context variables, and its predictive scope with behaviour.

In relation to the predictive scope of MT on behaviour, the theory establishes that both states and traits influence behaviour and performance in sports (Hanin, 2000; Piepiora, 2021). Along these lines, Numerous studies have documented a positive association between MT and performance (Amemiya & Sakairi, 2019; Beattie et al., 2017; Beauchamp et al., 2021; Meggs et al., 2019) and with achievement (Bédard-Thom & Guay, 2018; Cowden et al., 2021; Danielsen et al., 2017; Slimani et al., 2016). While performance can be indicated by the outcome of a contest or an athlete's physical strength, an indicator of achievement could be the competitive playing standard (Cowden,

2017). Although there is a general consensus that MT contributes to athletic performance (Cowden, 2017; Jackman et al., 2017; Morris & O'Connor, 2016), few researches have been able to establish a relationship between mental toughness and objective and meaningful indices of sporting success (Cooper et al, 2021; Jones & Parker, 2017; Marshall et al., 2017).

With regard to the temporal stability of MT, while there is a tendency to assume that only states fluctuate across time, evidence suggests that traits are also susceptible to changes, in response to contextual variables such as clinical interventions (Roberts et al., 2017; Stieger et al., 2022), transition through stages of the life cycle (Durbin et al., 2016; Hill et al., 2022; Roberts et al., 2006) and academic demands (Alessandri et al., 2020). If MT is a trait, it should not change in considerably shorter periods of time than those reported in previous literature (i.e., less than four weeks) (Roberts et al., 2017; Stieger et al., 2022).

Notwithstanding the foregoing, the literature suggests that not every personality trait (and its effects on behaviour) changes over time in the same significant way, and not all of them are affected by contextual variables in the same way. The interactional model of personality also suggests that the assessment of an individual's predisposition must be made with specific reference to the situational context (Endler et al., 1991). Therefore, the approach to the temporal stability of the construct must also consider its relationship with the context. In this line the evolution in the third wave of MT research, which is focused on the interaction between behaviours and situations relevant to MT (Gucciardi & Hanton, 2016). In the case of MT, some contextual variables that have been associated with changes in MT levels are the coaching environment and effective coach and athlete communication, mental preparation, instruction and drilling (Hunt et al., 2020); long-term development focus, holistic quality preparation (i.e. preparing athletes both within and outside of sports) (Li et al., 2019); difficulty in organising leisure time (Nas & Temel, 2019); playing experience and the type of sport (Rintaugu et al., 2022).

A contextual variable that has been little studied in the case of MT could be the different competitive phases of a season (i.e., pre-season, regular season and post-season). Several scholars have suggested that athletes' emotion and behaviour changes across the phases of sporting tournaments (Abad-Tortosa et al., 2019; Al-Yaaribi et al., 2017; Gaudreau et al., 2002; Schaefer et al., 2016). However, with the exception of Drees & Mack (2012) and Clark et al. (2023), MT has not been studied in relation to the course of a competitive season. Moreover, competitions are often partly perceived as a source of threat due to the possibility of incurring injuries and not fulfilling one's own or others' expectations (Gaudreau et al., 2002). Close to the time of competitive action, athletes usually experience a significant increase in anxiety, tension and fear; but also, vigour, enjoyment, fun and contentment. After a competition, they generally feel disengagement from the contest, a decrease in anxiety and tension, and a lessening of positive engagement and pride. They also experience shame, guilt or humiliation (Cerin & Barnett, 2006).

In view of the above considerations, we can assume that the "trait/state" problem in MT is to understand how the context, and MT, with their possible changes and interactions, generate effects on behaviour and sports results over time, which means that the research designs proposed should allow us to observe these complex interactions.

Despite these, little empirical research has been conducted to directly examine these relevant issues. In addition, most of the studies that explored MT's relationship with athletic performance used markers that lack sufficient sensitivity and specificity (Cowden, 2017). From those limitations identified by scholars, the question arises about whether or not MT changes over time and context, and if MT can predict sporting performance. Along these lines, emerging evidence suggests that the MT literature on dimensions of athletic performance lacks longitudinal studies to establish causal sequences of relationships between variables (Anthony et al., 2016; Cowden, 2017; Danielsen et al., 2017). In order to answer those questions, a longitudinal study would be appropriate because this involves repeated observations in time of the same subjects and in different contexts (i.e., during competition and post competition), therefore permitting an examination of the traitness of MT and its relationship with sport performance. If MT is a trait, statistically significant differences should not be observed between different phases of the sporting season, given that changes in personality traits occur across longer periods of time. Furthermore, MT should not be predicted by a contextual variable and its effects on sports performance should also be stable regardless of the changes in context. If MT is a state, there should be statistically significant differences between phases, and MT should be predicted by a contextual variable and its predictive scope on the behaviour of athletes in the game will not be statistically significant. Consequently, the objective of this research is to contrast empirically whether the eventual changes in MT and its relationships with competition phases and sporting performance can sustain the notion of MT as a state or a trait.

Methods

Participants

The present sample consisted of 12 male rugby players, aged 18-33 years (M = 27.57, SD = 4.72). All athletes regularly competed at the highest national level and two of them were part of the Chilean national rugby team. They did not always play in the same position.

Procedure and variables

Athletes were provided with a general verbal description of the study, after which each rugby player signed an informed consent that assured their anonymity. The study was conducted in accordance with the Declaration of Helsinki and was approved by the relevant University Ethics committees (FADEUP - Faculty of Sport of University of

Porto). The participants were equipped with a GPS system (Carling et al., 2009), which allowed the measurement of performance variables during four consecutive games played over two tournaments in a six-month period obtaining four measurements in the same group of players. This time frame was chosen because previous literature tracked changes in personality traits over a 1-to-6-month period (Alessandri et al., 2020; Roberts et al., 2017; Stieger et al., 2022). The performance variables measured are detailed below:

- *Total Time:* Number of minutes played by a player during a game.
- *Speed*: A speed indicator that results in dividing the *total distance* by the *total time* of the game in seconds.
- *High Intensity Distance:* The total metres ran by the player at high intensity, exceeding his own mean Maximal Aerobic Speed (MAS).
- *Maximal Speed:* The highest speed reached by the player during a game.
- *Number of Impacts*: The number of forcible contacts received by the player during a game, typically collisions or tackles. This is an indicator of the volume of physical work done by a player during a match.
- *Accelerations*: Number of increases of speed made by the player during a game.
- *Decelerations*: Number of decreases of speed made by the player during a match.
- *Game Points*: Number of points scored by the player during the match.
- *Player Load*: The summation of all accelerations, decelerations, jumps, goal attempts and impacts of the player during a game. This is another indicator of the volume of physical work.

Finally, two concepts were considered as psychological and contextual variables respectively:

- *Mental Toughness* (MT): This was measured with the Mental Toughness Scale (MTS; Madrigal et al., 2013) validated in Chile by Guzmán-Muzante et al. (2024) which is composed of 11 items, measured on a 5-point Likert-Scale, ranging from 1 (strongly disagree) to 5 (strongly agree), with an unifactorial structure and a .89 level of reliability. Athletes completed the mental toughness questionnaire online.
- *Competition Phase* (CP): the four games analysed were classified in *Preparation* (first and third game) and *Competition* (second and fourth game) according to the classical model of sport planning described in Costa (2013), because within these four games, the first and third were part of preparation training for the tournaments whose results were not considered for the competition, while the second and fourth games were part of the tournament itself, and in consequence, their results affected the results of the competition.

Data Analysis

Data was coded and analysed with Statistical Package for Social Sciences (SPSS) Version 28 software. First of all, descriptive statistics were calculated in all study variables in the four games analysed. In addition, two statistical techniques were used in this research: ANOVA repeated measures and the Poisson Regression Model, which are appropriate means for examining longitudinal data with scalar and ordinal variables respectively (Twisk, 2013). In order to meet the first objective, ANOVA repeated measures were applied on four measurements of MT in order to know if there were significant differences in these indicators. In addition, a Poisson Regression Model was applied where the CP was a predictor of MT with the purpose of knowing if the MT levels are predicted by the CP (i.e., a contextual variable). On the other hand, to meet the second objective, nine Poisson regression models were proven, where MT and CP were the independent variables and each performance variable was a dependent one. These models showed whether MT and CP are significant predictors of the athletes' behaviour and results.

Results

First of all, descriptive statistics of the study variables in the four games analysed are detailed in Table 1. With regard to differences between the preparation and competition matches, it can be observed that the highest speed average of 76 metres per minute was observed in the third game (Preparation). Likewise, the highest high intensity distance average of 809.1 metres occurred in the third match (Preparation).

Regarding player load, results show that the highest number of 270 was observed in the second game (Competition). In relation to accelerations and decelerations, the highest average of 80.6 and 80.4 metres per minute respectively occurred in the third match (Preparation). Likewise, the highest number of impacts of 8.58 was observed in the third game (Preparation). With regard to maximum speed, the highest average of 26.6 metres per minute occurred in the third match (Preparation). In relation to game points, the highest average of 1.25 points was observed in the first game (Preparation). Finally, regarding MT, the highest average of 3.39 occurred in the fourth game (Competition).

Table 1.
Descriptive statistics (mean ± SD) variables/games

	First game (Preparation)	Second game (Competition)	Third game (Preparation)	Fourth game (Competition)
Total Time	75.3 ± 6.75	73.6 ± 8.61	81.9 ± 7.34	76.1 ± 8.73
Speed	68.6 ± 5.17	66.4 ± 2.53	76 ± 4.02	64.2 ± 6.04
High Intensity Distance	689.8 ± 292.9	688 ± 223.7	809.1 ± 256.6	546.8 ± 204.6
Player Load	243.4 ± 37.19	270 ± 29.4	264.7 ± 21.5	223.5 ± 41.3
Accelerations	79.8 ± 14.0	67.7 ± 10.8	80.6 ± 14.1	56.2 ± 17.2
Decelerations	69.4 ± 14.65	71.7 ± 7.57	80.4 ± 15.5	58.2 ± 17.0
Number of Impacts	3.83 ± 1.04	4.40 ± 1.79	8.58 ± 2.87	4.10 ± 2.72
Maximal Speed	25.9 ± 2.71	26.3 ± 3.36	26.6 ± 2.54	26.5 ± 2.56
Game Points	1.25 ± 2.26	0.58 ± 2.02	0 ± 0	0.83 ± 1.94
Mental Toughness	3.34 ± 0.39	2.99 ± 1.06	3.27 ± 0.22	3.39 ± 0.35

Table 2 summarises the significance of each Poisson Regression model and their parameters. Additionally, there are no significant differences in MT between the four measurements (F=.97; p>.05). Furthermore, the Poisson Regression model applied with CP as a predictor of MT was not statistically significant (χ^2= .54; p>.05).

Table 2.
Poisson Regression Models

Dependent Variable	χ^2	p value	Independent variable	B	df	p value
Total Time	2.65	0.27	Mental Toughness	-3.00	1	0.40
			Competition Phase	0.06	1	0.14
Speed	10.7	0.01	Mental Toughness	0.09	1	0.27
			Competition Phase	0.18	1	0.00
High Intensity Distance	699.6	0.00	Mental Toughness	0.30	1	0.00
			Competition Phase	0.44	1	0.00
Maximal Speed	0.41	0.81	Mental Toughness	0.07	1	0.52
			Competition Phase	0.01	1	0.96
Number of Impacts	9.28	0.01	Mental Toughness	-9.00	1	0.41
			Competition Phase	0.43	1	0.00
Player Load	42.6	0.00	Mental Toughness	0.03	1	0.51
			Competition Phase	0.17	1	0.00
Accelerations	51.9	0.00	Mental Toughness	-10.0	1	0.00
			Competition Phase	0.28	1	0.00
Decelerations	25.6	0.00	Mental Toughness	-10.0	1	0.00
			Competition Phase	0.18	1	0.00
Game Points	6.26	0.04	Mental Toughness	1.06	1	0.03
			Competition Phase	-19.0	1	0.59

In addition, Table 2 details information on two types of models: one in which MT and CP act as independent variables and jointly predict the scores on the previously described dependent variables. Another in which MT and CP also serve as independent variables, but separately, thus predicting the levels of the same dependent variables. The Models of MT and CP are statistically significant for *speed, high intensity distance, number of impacts, player load, accelerations, decelerations* and *game points*. In addition, the B parameters indicate that MT is a positive and statistically significant predictor of *high intensity distance* and *game points* and a negative and statistically significant predictor of *accelerations* and *decelerations*.

Discussion

The objective of this paper was to empirically contrast whether eventual changes in MT and its relationships with competition phases and sporting performance could sustain the notion of MT as a trait or a state. Along these lines, the data suggests that MT has enduring properties across context and time and has predictive power over behaviour, because there are no significant differences in MT between the four measurements and that CP did not predict MT. The models of MT and CP were statistically significant predictors for the variable's metres per second, high intensity distance, number of impacts, player load, accelerations, decelerations and game points. In addition, the data suggested that MT is a positive and statistically significant predictor of high intensity distance and game points and a negative and statistically significant predictor of accelerations and decelerations.

However, these findings are not conclusive with regard to the traitness of MT. These results align with past work that conceives MT as a trait (Bell et al., 2013; Drees & Mack; 2012; Hardy et al., 2014). In addition, some of those scholars that conceptualise MT as a stable construct (Bell et al., 2013) demonstrated that it is amenable to change and development through systematic interventions that contemplate repeated exposure to punishment-conditioned stimuli and coping with pressure, amongst other methods. As there was no control of the intervening variables of interest (i.e., non-experimental design) and no intervention with the rugby players (i.e., an MT training program) in this research, the results are consistent with previous literature (e.g., Gucciardi et al., 2015) that suggested that MT is both stable and dynamic in nature. In other words, MT does not seem to change in short periods of time (i.e., six months) as long as there are no specific programmes to develop it. Moreover, Stamatis et al. (2022) found significant differences in MT scores between North American and Mexican athletes, suggesting that cultural context can influence the construct's expression, further supporting the idea that MT is both trait-like and responsive to environmental factors.

With regard to the relationship between MT and sporting performance, the results indicated that MT has statistically significant relationships with some performance indices, but not all. To the best of the authors' knowledge, this is the first study to use performance markers with sufficient sensitivity and specificity for rugby union. More importantly, this is the first research study that has shown that MT is a positive and statistically significant predictor of high intensity distance and game points and a negative and statistically significant predictor of accelerations and decelerations in rugby. Although it is not possible to establish causality interpretations among MT and performance indices, the current findings provide the impetus for researchers to

examine causality. MT has been defined as "a collection of values, attitudes, behaviours, and emotions that enable you to persevere and overcome any obstacle, adversity, or pressure experienced, but also to maintain concentration and motivation when things are going well to consistently achieve your goals" (Gucciardi et al., 2008, p. 278). Aligned with this definition, MT can be observed in behaviours like high intensity distance and game points, which were displayed in the face of adversity; or in actions as accelerations and decelerations, exhibited when things were going well. The findings suggest that MT facilitates performance in high-pressure situations that require the activation of the athlete's potential for action towards an objective (Giles et al., 2017), such as running long distances at a high speed to score and win the game. Furthermore, the negative and statistically significant relationships between MT and accelerations and decelerations, support the idea that MT operates also in favourable settings, so athletes know when they need to increase their efforts to achieve victory, and when they do not. The results of this study are in agreement with those of Dewhurst et al. (2012), who suggested that people with higher MT had the ability to prevent unwanted information from interfering with their current goals (e.g., scoring), and with Aditya et al. (2024), who pointed out that "athletes with superior mental toughness perform better on motor and cognitive tasks and achieve superior exercise results" (p. 333). On the contrary, players with a lower MT would probably think too much about past mistakes (e.g., dropping the ball), diminishing their focus on the relevant tasks, therefore affecting their performance. Additionally, the findings of this research align with Beattie et al. (2017), which indicated that athletes who are sensitive to punishment and insensitive to reward display stronger MT behaviours and consequently, swim faster. In other words, as with swimmers, mentally tough rugby players tend to be more punishment sensitive, detecting threats early (e.g., a very strong and fast adversary) in training sessions, so that they can develop self-regulated behaviours that allow them to deal with those threats during official games (e.g., run faster when necessary). The results are also consistent with Aditya et al. (2024), who found that high mental toughness enables athletes to surmount tension and depression during competition. Moreover, data indicated that athletes' performance (i.e., behaviour) was predicted by MT, the competitive phases or both. Therefore, sporting performance is sometimes predicted by internal variables, at other times it is predicted by contextual variables, and sometimes by both. MT has been defined as a purposeful and flexible resource, which can be seen in specific behaviours in response to contextual demands. These demands are apparently mediated by MT. Consequently, athletes continually evaluate contextual demands (e.g., remaining focused on a place kick despite the chanting of fans). Accordingly, they decide whether or not they need to activate this resource to aid their sporting performance.

There are several limitations that are associated with this study that should be highlighted for further investigation. Amongst them is the use of self-reported data to measure MT, which introduced concerns associated with common method biases. In that regard, it would be expected that future research adopts multi source approaches to asses MT, such as behavioural measures (Diment, 2014; Houwer et al., 2017) or coach ratings of MT (Beattie et al., 2017; Bell et al., 2013; Hardy et al., 2014), in order to increase the internal validity of the study. Moreover, the use of a non-experimental design neither permits causality interpretations of the relationships among study variables, nor allows the contrasting of its interaction effects, especially in specific variables of the competitive phases such as a coach's style, sports strategies, interactions between team members, etc.

A key priority for future research on this subject should be employing more experimental and longitudinal designs, allowing simultaneous observation of how MT scores behave in time and across different groups with multiple experimental and control conditions. In consequence, it could help to deepen understanding of the underlying mechanisms of MT, enlightening its relationships with internal and contextual variables. Additionally, the time frame of six months was not long enough to identify changes in MT. Therefore, future MT longitudinal studies could consider researching this topic over longer periods of time to determine when and how MT changes in the life of athletes. Moreover, future research should continue to investigate the role MT (i.e., as an internal resource) has in mediating the relationship between contextual variables (e.g., competitive phases) and sporting performance. Furthermore, the fact that MT was not a statistically significant predictor of some performance markers (i.e., total time, metres per second, maximal speed, number of impacts and player load) indicate that there may be a number of other factors that also considerably contribute to the rugby players' performance. These could include physical (e.g., high intensity distance), technical (e.g., kicking technique), tactical (e.g., choosing to kick for touch or run with the ball), contextual (e.g., coach leadership) and other psychological qualities of the players (e.g., self-dialogues, coping strategies, decision-making, etc.), their teammates and opponents. In addition, this research was conducted solely with Chilean Rugby players, employing a convenience sample, thus limiting the generalizability of its findings. Accordingly, future MT research could replicate and extend our results by focusing on samples amongst other South American countries, also include different sport disciplines (i.e., team, individual, contact and non-contact) and diverse competitive standards (e.g., youth and senior sports). Additionally, in the case of team sports it would be relevant to analyse the MT of athletes according to their playing positions (e.g., backs vs forwards). Consequently, one of the questions that remains unanswered at this point is how does a mentally tough athlete behave? Moreover, which are the conditions that trigger those behaviours? Even though some scholars have addressed this topic in cricket (Bell et al., 2013), football (Diment, 2014) and tennis (Houwer et al., 2017), this may be

particularly relevant for research on this subject. Notwithstanding evidence suggesting that MT has relatively enduring properties, apparently its manifestations are not, as athletes cope differently with adversity and favourable circumstances in each sport.

Finally, the data from this research provides quantitative support for the expectation that MT operates more like a trait than a state, given that it is an attribute that does not change significantly over time, was not greatly influenced by the CP and its effect on sporting behaviour was stable in its significance and direction.

Conclusion

This paper presents evidence to suggest that MT has enduring properties across context and time and has predictive power over behaviour, because there are no significant differences in MT between the four measurements and that CP did not predict MT. The models of MT and CP were statistically significant predictors for the variable's metres per second, high intensity distance, number of impacts, player load, accelerations, decelerations and game points. In addition, the data suggested that MT is a positive and statistically significant predictor of high intensity distance and game points and a negative and statistically significant predictor of accelerations and decelerations.

Conflict of Interest

The authors declare no conflict of interest.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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