Maradona in our minds: The FIFA World Cup as a way to address collective memory properties

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Abstract

The FIFA World Cup football tournament is one of the most widely watched sporting events in the world. Particularly, the Argentina national football team has appeared in five World-Cup finals and support for this team has been a long-standing tradition in this country. In the present study, we asked whether the FIFA World Cup constructs a significant collective memory and to what extent this informal memory is similar to collective memories acquired in more formal settings. An online memory task was conducted asking a large group of Argentinian adults ($N=407$) which country was the winner, the runner-up, and the host of each tournament from 1930 to 2014. In addition, participants were asked to rank the emotional content and the response confidence of each tournament. Finally, participants reported a number of keywords associated with each tournament, to measure memory detail. Our results reveal the existence of a robust collective memory for the World Cup events, showing a high degree of memory accuracy and detail with regard to the history of the tournaments. Furthermore, an independent replication study ($N=124$) confirmed our findings. More specifically, we found evidence for general principles of individual memories in FIFA World-Cup informal collective memories. These results suggest that informal collective memories share common attributes with more formal collective memories such as those found in presidents or wars. Thus, collective memory properties may be independent of the conditions under which their acquisition occurs.

Keywords Collective memory · Football · Forgetting · Serial position effect · Informal learning

Introduction

Collective memory, sometimes called historical or popular memory, refers to the representation of the past shared by a group (Hirst, Yamashiro, & Coman, 2018; Roediger & Abel, 2015). This type of collective representation involves episodic, semantic, and implicit components such as beliefs, feelings, rituals, and knowledge of the past that contributes to a group's identity (Manier & Hirst,

2008; Schwartz, 2008). There is an implicit division of labor in the social sciences in which sociologists and anthropologists typically investigate collective phenomena, while psychologists and neuroscientists handle questions pertaining to the minds of individuals (Boyer & Wertsch, 2009; Hirst & Manier, 2008). However, the last few years have witnessed a growing interest amongst psychologists in the way in which people recall their past (Hilton & Liu, 2017; Hirst & Manier, 2008; Roediger & DeSoto, 2014; Roediger & Abel, 2015; Wertsch, 2002).

The study of collective memory has been typically focused on historic milestones for a nation's past, such as presidents, wars, or political leaders (e.g., Fu, Xue, DeSoto, & Yuan, 2016; Zaromb, Butler, Agarwal, & Roediger, 2014). This type of knowledge is usually learned in formal education settings, such as in schools or from textbooks, and it has a fundamental value for an individual's academic success and citizenship formation. Research on these formal collective memories have been mostly focused on three avenues. The first line of studies proposes that collective memories are organized as a body of shared knowledge, which reveals common effects with individual memory traits and collective memory (Roediger & Abel, 2015). For example, a series of recent studies (Fu, Xue, DeSoto, & Yuan, 2016; Roediger & DeSoto, 2014; Roediger & DeSoto, 2016) showed common

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memory traits such as the serial position effect, the distinctiveness effect (von Restorff effect), the forgetting function, and the false-fame effect. In an influential study, Roediger and DeSoto (2014) analyzed presidential-recall tests performed with three generations of undergraduate college students (1974, 1991, and 2009). Americans' recall of the presidents generally followed a classic serial position function (i.e., best recall for the first and the most recent presidents). A second line of research of formal collective memories involves its narrative structure, which serves as a schema to interpret a group's past (Wertsch, 2002). This schema establishes meanings, relative event importance and rules of remembering within a group, constraining the memorability of public events, highlighting some of them and overshadowing others (Nelson, 2003; Roediger & Abel, 2015). For example, a number of studies found that people overestimate their nation's role in world history, i.e., express a national narcissism (Zaromb et al., 2018) and recall the same event with different perspectives (Putnam, Ross, Soter, & Roediger, 2018; Roediger et al., 2019). Finally, a third line of studies on collective memories focuses on the process of memory change over generations. In this sense, a recent study (Zaromb, Butler, Agarwal, & Roediger, 2014) showed that both younger and older Americans listed the US bombings of Japan as a critical event in World War II. However, older adults rated the bombings quite positively (i.e., the bombs ended the war), whereas younger adults rated the bombings as negative (i.e., the bombs killed and injured thousands of civilians; the war would surely have ended soon anyway). This study shed light on the importance of whether the events are experienced personally or learned from historical sources.

How are collective memories established? While formal learning is highly institutionalized and the focus of government policies, informal learning occurs every day in a multitude of ways and in a range of unstructured settings such as relational, experiential, and incidental ones (Eshach, 2007; Martin, 2004). Moreover, in contrast to informal learning, formal learning is commonly instructed by teachers, it has a sequential structure and it is evaluated (Eshach, 2007; Straka, 2005). Most studies on collective memories are focused on historical events that are subject to formal instruction, such as political leaders and wars (Zaromb, Butler, Agarwal, & Roediger, 2014). Only a few studies examined the organization as a body of knowledge of informal collective memories, with mixed results (Kelley, Neath, & Surprenant, 2013; Spivack, Philibotte, Spilka, Passman, & Wallisch, 2019). Kelley et al. (2013) found a serial position effect for movies and books, while more recently, Spivack et al. (2019) analyzed collective memory for popular music and suggested that it is different from that of other historical phenomena. One difficulty when interpreting these results is the fact that these informal collective memories do not have a clear chronological order such as the presidents or wars. Moreover, the offer of cultural media (books, movies, music) is huge and in permanent change, which leads to a faster decay in attention (Candia, Jara-

Figuroa, Rodriguez-Sickert, Barabási, & Hidalgo, 2019). Here, in order to study the organization of knowledge of an informal collective memory, we used the *Fédération Internationale de Football Association* (FIFA) World Cups. The advantage of this approach is in: (1) the clear chronological order of the tournaments, (2) its periodical occurrence (every 4 years), (3) its emotional impact (Albareces, 2003), and (4) the way it bounds with national identity (Williams, 2017).

FIFA World Cup as a way to address informal collective memory properties

Every 4 years, the daily routine of many people in the world becomes dominated by a single word: football (soccer). The FIFA World Cup is the most important tournament, as well as the most widely viewed and followed sporting event in the world, exceeding even the Olympic Games and the Super Bowl. The cumulative audience for all matches of the 2018 FIFA World Cup was officially estimated at 3.4 billion viewers,¹ nearly half of the entire population of the planet. This championship has been awarded every 4 years since the inaugural tournament in 1930 (except in 1942 and 1946 when it was not held because of World War II). Sports are known for helping the formation of national identities and narratives (von Scheve, Beyer, Ismer, Kozłowska, & Morawetz, 2014; Williams, 2017). In Argentina this football passion is particularly intense, and the support for the national football team is a long-standing tradition and part of the national identity (Albareces, 2003). Since its establishment, the Argentina national team has appeared in five FIFA World Cup finals, winning the championship in 1978 and 1986. Two of the players, Diego Maradona and Lionel Messi, are two of the greatest football players of all times, and their names are known worldwide.² Although more than 30 years have passed since what was considered to be the “goal of the Century”,³ a goal by Maradona against the English team in the quarter-finals of the 1986 World Cup, most Argentinians still talk about it (Albareces, 2003). Some people can even recall a famous sportscaster commentary about that goal, describing Maradona

¹ <https://www.fifa.com/worldcup/news/more-than-half-the-world-watched-record-breaking-2018-world-cup>

² Assuming that Wikipedia is a good predictor of general knowledge and users' general behavior (see: García-Gavilanes, R., Mollgaard, A., Tsvetkova, M., & Yasseri, T. (2017). The memory remains: Understanding collective memory in the digital age. *Science Advances*, 3, no. 4, e1602368), a quick search of this platform reveals that the entries regarding Diego Maradona and Lionel Messi are on top of the list of the number of translations into different languages in relation to other sports, organizations, or religious figures. The number of translations in each Wikipedia entry are: Olympic Games (161), Pope Francis (151), Messi (135), Roger Federer (129), Cristiano Ronaldo (125), FIFA (119), Brazil World Cup 2014 (109), Diego Maradona (107), Dalai Lama (101), Michael Jordan (94), Michael Phelps (92), Johan Cruyff (89), NBA (88), Michel Platini (78), Tiger Woods (78), Robert Lewandowski (74), Alfredo Di Stefano (64), Super Bowl (61).

³ <https://www.fifa.com/worldcup/matches/round=714/match=392/classic-match/index.htm>

as a “cosmic kite.” Remarkably, this information is not learned at school, nor in any formal environment. Thus, this is a type of shared and informal knowledge that lends itself to addressing the properties of collective memory.

The current research

Memories of the World Cup represent an opportunity to study a collection of common knowledge with emotional content, which is independent of a generation’s formal education. Information about the World Cup is acquired principally through the media (radio, internet, newspapers), social interaction, and, occasionally, direct exposure. The present study aimed to investigate the collective memory of Argentinians for the FIFA World Cup and ultimately analyze if this informal knowledge behaves similarly to collective memories acquired in more formal settings.

Our general hypothesis is that this informal body of knowledge could represent a robust informal collective memory and might reveal common effects with more formal collective memories. In particular, we investigated: (1) the overall knowledge (memory accuracy and detail) with regard to all World Cups up till 2014 (1930–2014); (2) their association with subjective football value and emotion; and (3) the role of age and memory of individuals with regard to forgetting curves. To these aims, we conducted an online task in which we asked a large group of Argentinian adults (older than 18 years) which country was the winner, the runner-up, and the host of each FIFA World Cup tournament that took place from 1930 to 2014. In addition, participants were asked to rate the confidence of each response, and the emotional content of each tournament. Finally, participants reported a number of keywords associated with each World Cup tournament, to measure the detail and also narrative content of the memory. Thus, we examined individual memory accuracy and content from a multidimensional approach to characterize and understand informal collective memories.

Methods

Main study

Participants

A total of 696 Argentinian subjects ranging in age from 18 to 77 years (mean $\pm$ SD age 29.6 ± 9.0) were recruited from Facebook, Twitter, and via email to participate in the current study. Only participants who completed at least 75% of the questionnaire were included in the analysis. That is, taking into account that the survey followed a chronological order, ranging from the first (1930) to the 20th (2014) FIFA World

Cup tournament, we only included participants who got up to at least the 15th tournament. The final sample consisted of 407 subjects (297 males and 110 females; see Table 1 for the demographic profile of the sample).

Adequacy of sample size and power was analyzed using the Webpower R package (<https://webpower.psychstat.org/wiki/>). This analysis revealed that for high power (0.8) and a type I error of 0.05 at least 103 participants are required.

Procedure

The experiment was conducted in the Socrative (by MasteryConnect; <https://www.socrative.com/>) online platform from October 2016 to November 2017. The survey was performed in Spanish, as it was targeted to Argentinean participants. Subjects were informed that they would complete an online survey about their memories and knowledge of each tournament of the FIFA World Cup. As mentioned above, the FIFA World Cup has been played every 4 years since 1930 (with the exception of 1942 and 1946), giving a total of 21 official tournaments. At the beginning of the experiment, subjects were asked to report their personal information (gender, nationality, and age) and then completed the following tasks:

- A) General football valuation (*0–3 scale of interest – one time only*).
- B) For each World Cup championship (in chronological order, 1930–2014).
 1. Which country was the winner? (*five-choice recognition*).
 2. Which country was the runner-up? (*five-choice recognition*).
 3. Which country was the host? (*five-choice recognition*).
 4. How confident are you in your three memory responses? (*0–3 scale*).
 5. Rank the emotional value of this championship (*0–3 scale*).
 6. Provide specific keywords for this championship.

Table 1 Age frequency and gender distribution of the participants in the main study

Age, y	N	Males
< 20	21	15
20–30	199	143
30–40	137	105
40–50	28	21
> 50	19	11

Measures

Valuation Subjects were asked to rate their overall interest in football using a scale from 0 (not interested) to 3 (fanaticism).

Memory accuracy For each FIFA World Cup, participants were asked the following questions, using a five-choice recognition procedure: “Which was the host country?” “Which country was the winner?” “Which country was the runner-up?” The four foils were designed to be plausible, always including countries that were champions in the previous or following tournament. Each correct response was worth one point. Memory accuracy was estimated using the percentage of the sum of the three responses per subject per World Cup. There were no significant differences between the three accuracy questions (repeated-measures ANOVA, Accuracy Question Factor $F(2.77) = 0.15$, $p > 0.05$; Winner = 0.67 ± 0.17 ; Runner-up = 0.60 ± 0.19 ; Host = 0.72 ± 0.19 ; $p > 0.05$ and no significant interaction between Accuracy Question and World-Cup tournament $F(38.428) = 0.805$, $p > 0.05$).

Confidence Participants were asked to rate the certainty about their three accuracy responses for each FIFA World Cup tournament, using a 0 (not confident) to 3 scale (absolutely confident).

Emotion Subjects reported how much they enjoyed or how emotional for them each tournament was, using a scale from 0 (not emotional) to 3 (totally emotional).

Memory detail After answering the accuracy questions, participants were instructed to write down keywords to describe specific details they recalled about each tournament. Importantly, as this was a “free-response” question, diverse types of answers were obtained, including names of players, countries, or entire phrases (e.g., for the 1986 tournament: ‘The Hand of God’). It was possible to leave a blank answer if no details were recalled. We quantify memory detail as the total number of words in each case, excluding connectors and numbers.

Statistical analysis

Main analysis To analyze participant’s memory accuracy, memory detail, emotion, and confidence across the 20 World Cup tournaments, each measure was entered as a repeated measure in a single within-subjects repeated-measure MANOVA using subject’s age as a covariate. Then, each dependent measure was followed up by separate repeated-measures ANOVA (RM-ANOVA) using the Bonferroni correction.

Memory and football valuation To study how memory accuracy and detail depends on football valuation we performed a one-way ANOVA followed by a Tukey post hoc test.

Influence of age (linear regression) To determine the decay of memory for World Cups that occurred prior to birth we aligned data with the birthdate of every participant and we performed a linear regression of memory accuracy and detail as a function of the number of championship tournaments since birth ($y = ax + b$).

Forgetting curves (nonlinear regressions) To study the nonlinear curve of forgetting we fitted memory accuracy with an exponential function of two parameters ($y = ae^{bx}$) using a nonlinear least-squares method.

Age and memory To study the relation between participant’s performance and age we split participants into two groups, older and younger than 30 years (alive and not alive during the 1986 World Cup, respectively, similar to Zaromb et al., 2014). We assessed a one-way ANOVA between the two groups for memory accuracy, detail, confidence, and emotion for the 20 tournaments.

All data were analyzed with MATLAB (Mathworks Inc., Natick, MA, USA).

Replication study

Due to the high levels of attrition (i.e., 42%) in the main study we decided to conduct an independent replication study using the recommendations outlined by Zhou and Fishbach (2016). Thus, to reduce the dropout-rates we: (1) reduced the number of questions (see *Materials* section), (2) used an “appealing to conscience” strategy where subjects before beginning the study, read a message highlighting the duration of the study and the importance of data quality, and (3) used an incentive and personalization strategy in which subjects gave their email and participated in a raffle drawing for a gift card in a bookstore. An independent sample of 139 individuals participated in the replication study with a 10.2% attrition level. Thus, the implemented changes significantly improved the dropout rates. The final sample of the replication study consisted of 124 participants (see Table 2 for the demographic profile of this sample).

Table 2 Age frequency and gender distribution of the participants in the replication study

Age, y	N	Males
< 20	19	4
20–30	74	46
30–40	16	12
40–50	12	10
> 50	8	7

The experimental procedure was similar to the one used in the main study but subjects were only asked one accuracy question (champion of each World Cup tournament) to reduce the duration of the survey.

As in the main study, we performed a single within-subjects repeated-measure MANOVA using subject's age as a covariate. Data from the main study and the replication study were analyzed separately.

Results

Main study

We found a main effect of World Cup tournament (repeated-measure MANOVA, Wilks' $\lambda = 0.822$, $F(76.18696) = 12.443$, $p < 0.001$, $\eta_p^2 = 0.08$) on each dependent measure (Memory Accuracy, Memory Detail, Emotion, and Confidence), showing significant differences across tournaments (1930–2014). Moreover, the significant interaction between tournament and age (Tournament $\times$ Age interaction: Wilks' $\lambda = 0.961$, $F(76.18696) = 2.447$, $p < 0.001$, $\eta_p^2 = 0.01$) revealed the contribution of participants' age to the World Cup measures.

Memory accuracy and detail throughout the history of FIFA World Cups

Follow-up RM-ANOVA revealed a significant Tournament effect on memory accuracy ($F(19.4674) = 18.526$, $p < 0.001$, $\eta_p^2 = 0.08$) and detail ($F(19.4674) = 3.745$, $p < 0.001$, $\eta_p^2 = 0.015$), and a significant interaction with age for accuracy (Tournament $\times$ Age Interaction $F(19.4674) = 3.981$, $p < 0.001$, $\eta_p^2 = 0.03$) but not for detail ($F(19.4674) = 0.790$, $p = 0.72$). Figure 1 shows the results corresponding to memory accuracy (upper panel) and memory detail (lower panel). Regarding accuracy, results show that the grand average (dotted line) is 66.4%, three times the random level (dashed line), revealing an overall high memory precision, which exceeds chance performance. Memory detail (lower panel) measures the number of keywords per World Cup, showing a total average of three words per response (dotted line) and presents a similar dynamic to accuracy, with both measures significantly correlated ($p < 0.0001$; $\rho = 0.8$). As expected, memory accuracy varies throughout the time series, showing peaks of nearly 90% of correct responses in 1978 and 1986, when Argentina won the championship, and in 2014, the closest World Cup tournaments at the time of our questionnaire. In fact, these three tournaments were significantly better recalled than the other 17 tournaments ($p_{1978\text{-all}} < 0.001$, $p_{1986\text{-all}} < 0.001$, $p_{2014\text{-all}} < 0.001$) and subjects were also capable of recalling more details ($p_{1978\text{-all}} < 0.001$, $p_{1986\text{-all}} < 0.001$, $p_{2014\text{-all}} < 0.001$). On the other hand, the early tournaments

reveal a lower than average accuracy, while the initial 1930 World Cup reveals a higher accuracy and detail level than the two subsequent points ($p < 0.001$). In this sense, a serial position effect is characterized by an enhancement of the recall of the beginning and end items of a list, called primacy and recency effect, respectively (Roediger & DeSoto, 2014).

Another characteristic of the serial position function is that a distinctive event could be well recalled even if it is in the middle of a list. For example, the 1950 World Cup shows a peak in memory detail, which corresponds to the “*Maracanazo*,” one of the most memorable events in the history of the World Cup, when Uruguay defeated the heavily favored host country Brazil. Memory accuracy for the 1950 World Cup tournament was better than the previous ($p_{1950-1938} < 0.05$) and subsequent tournaments ($p_{1950-1954} < 0.05$). Thus, our results point to the presence of a primacy and recency effect in the memory of the FIFA World Cup time series, as well as a distinctiveness effect, evidenced by the highest performance in the years corresponding to Argentina winning the championship compared to the surrounding tournaments.

However, it might be possible that our results are not a product of the ordinal position but instead are related to how well Argentina did at each World Cup. Therefore, we performed a correlation between Argentina's final position (indicated in the upper side of Fig. 1) and memory performance. Interestingly, memory detail shows a significant correlation with final position ($p = 0.01$; $\rho = -0.6$) while memory accuracy did not reach significance ($p = 0.11$; $\rho = -0.4$). That is, the better Argentina performed in the championship, the more vivid the episodic detail, and vice versa. This result suggests the presence of a self-centered (i.e., Argentina-oriented) memory and a self-reference effect (Klein & Kihlstrom, 1986; Symons & Johnson, 1997). That is, information related to the self is better recalled and organized. Thus, we analyzed the correlation between memory accuracy and detail with Brazil's final position. Importantly, Brazil is the most successful national team in the history of the World Cup (having won five titles) and Argentina's historic rival. Our results show that neither memory accuracy nor memory detail presented a significant correlation with Brazil's final position ($p = 0.7$ and $p = 0.9$, respectively), thus emphasizing the notion that participants only have a more vivid memory in the cases where Argentina performed better in the tournament (Rathbone et al., 2008).

In addition, memory detail allows us to address the narrative content of the World Cup memory. Supplementary Fig. S1 displays the most mentioned words of detail memory across all tournaments (1930–2014), arranged in size according to the frequency of appearance. As is evident, mention of “Maradona” is the most frequent, followed by “Argentina,” and “World Cup,” then “Brazil.”

Finally, we also measured memory confidence in each World Cup, as displayed in Table 3. This memory

Fig. 1 Memory accuracy and detail. Mean value and standard error of memory accuracy (black line) and memory detail (blue line) for each FIFA World Cup. Memory accuracy is the percentage of the sum of the three responses per subject per World Cup. Memory detail is the total number of words recalled about each championship per subject. The

black dashed line is the random level of memory accuracy (20%). Dotted lines represent the overall average of memory measures (accuracy: black and detail: blue). Argentina's final position for each tournament is displayed on top of the chart

quantification has a similar dynamic and peaks (1930, 1950, 1978, 1986, 1990, and 2014) to the previous memory measures (Tournament main effect RM-ANOVA $F(19.4674) = 18.030$, $p < 0.001$, $\eta_p^2 = 0.07$; Tournament $\times$ Age Interaction $F(19.4674) = 1.340$, $p = 0.15$). Moreover, memory confidence has a significant correlation with memory accuracy ($p < 0.0001$; $\rho = 0.9$) and with memory detail ($p < 0.0001$; $\rho = 0.9$). These results are in line with the idea that richer memories are associated with higher response confidence, vividness, and detail recollection (Rubin & Talarico, 2017).

Relationship between emotion, football valuation, and memory measures

We analyzed the relation of emotion with overall football valuation on memory accuracy and detail. A follow-up RM-ANOVA revealed that emotion levels varied across the different World Cup tournaments (RM-ANOVA $F(19.4674) = 9.532$, $p < 0.001$, $\eta_p^2 = 0.08$; Tournament $\times$ Age Interaction $F(19.4674) = 0.762$, $p = 0.755$). Figure 2 shows the reported emotion per World Cup, and reveals a similar pattern to memory accuracy and detail, with peaks in 1950, 1978, 1986, 1990, and 2014. Similar to accuracy, these World Cup tournaments reported the highest levels of emotion compared to the other tournaments (i.e., $p_{1978\text{-all}} < 0.001$, $p_{1986\text{-all}} < 0.001$, $p_{2014\text{-all}} < 0.001$). In this sense, a significant correlation is found between emotion and memory accuracy ($p < 0.001$; $\rho = 0.8$) and between emotion and memory detail ($p < 0.001$; $\rho = 0.9$). Thus, collective memory appears to be

associated with emotional levels, as it is usually reported in individual memories (Kensinger, 2009; McGaugh, 2000).

Table 3 Memory confidence in each FIFA World Cup (mean and standard error)

World Cup Tournament	Confidence (mean)	SEM
1930	2.00	0.06
1934	0.7	0.05
1938	0.5	0.04
1950	1.3	0.07
1954	0.6	0.05
1958	0.7	0.05
1962	0.7	0.05
1966	1.1	0.06
1970	1.0	0.06
1974	1.2	0.06
1978	2.3	0.05
1982	1.1	0.05
1986	2.3	0.05
1990	2.1	0.06
1994	1.7	0.06
1998	1.8	0.06
2002	1.8	0.06
2006	1.8	0.06
2010	2.0	0.06
2014	2.6	0.04

SEM standard error of the mean

Fig. 2 Relationship between emotion, football valuation, and memory measures. **(A)** Mean value and standard error of emotion level reported for each FIFA World Cup. Emotional level is rated between 0 (no emotion) and 3 (high emotion). Argentina's final position for each

tournament is displayed on top of the chart. **(B)** and **(C)** Memory accuracy and detail regarding football valuation. ** One-way ANOVA corrected by Tukey's post hoc test, $p < 0.01$

With regard to the valuation of football (Fig. 2B), 55 subjects were not interested at all in football (valuation = 0), 122 were a “little interested” (valuation = 1), 117 had “average” interest (valuation = 2), and 108 were “very interested” (valuation = 3). To analyze how Memory accuracy and detail depends on football valuation we performed a one-way ANOVA followed by a Tukey post hoc test. As expected, the results show an increase in memory performance according to a higher football valuation, both for accuracy ($F(3,1624)=42.5$, $p<0.001$, $\eta_p^2=0.27$) and for memory detail ($F(3,1624)=7.23$, $p<0.001$, $\eta_p^2=0.04$). For memory accuracy, a post hoc test showed that groups with valuations of 2 and 3 were not significantly different from each other, but differed from groups with valuations of 0 and 1 (Tukey post hoc test, $p < 0.001$), and these two groups were significantly different from each other (Tukey post hoc test, $p < 0.001$). On the other hand, for memory detail, the only group significantly different from the others is the one with the highest valuation (in all cases, $p < 0.001$). Thus, memory accuracy is better for subjects that had “average” interest or were “very interested” in football while the participants with the highest football valuation reported a greater number of keywords.

Memory for World Cups that occurred prior to birth deteriorates linearly, while the ones that occurred during early adulthood are most memorable

As we have seen above, memory accuracy is associated with age. Using memory accuracy, we calculated for each subject a “World Cup Total Knowledge” (proportion of correct responses for the 20 World Cup Tournaments) and found a

weak but significant correlation between variables ($\rho = 0.11$, $p = 0.03$). Older participants seem to have a better memory accuracy for the World Cups. However, we were interested in determining the influence of age at the time of the event on the memory accuracy and detail (Rathbone, O'Connor, & Moulin, 2017; Rubin, 1998). Firstly, we compared the memory accuracy and detail for World Cups that occurred prior to and after birth (Fig. 3). For that purpose, we adjusted data according to the birthdate of every participant, determining memory performance over eight World Cups before birth and four Word Cups after it. Our results show that memory for events prior to birth follow a linear deterioration function, both for Memory accuracy and for memory detail, indicating a forgetting process ($R^2=0.9$ for both memory performances). On the other hand, no deterioration was found for the World Cups that occurred after birth. From these results, we asked whether there is a difference in the participants' performance according to their age. Thus, we split our participants into two groups, based on the median age of the participants (i.e., 30 years): older or younger than 30 years. Figure 4 shows the results of Memory accuracy, detail, confidence, and emotion for all World Cup tournaments. Our results show that the older group (>30 years old, blue line) had a significantly higher accuracy in the World Cups between 1938 and 1998. Memory details, confidence, and emotion present a similar pattern but the differences between the groups are smaller. Since the 2002 World Cup, the younger group (<30 years, black line) has reached the level of the older group and even exceeds it in the emotion measure. These results suggest that subjects have better memory for experienced events relative to those learned from external sources.

Fig. 3 Age and memory of World Cups. Memory accuracy and detail as a number of FIFA World Cups since birth (black dots: mean and standard error). The negative (positive) values of the x-axis represent championships before (after) birth. Memory accuracy and detail prior to birth were

adjusted with a linear function (red line, $y = ax + b$). Both linear regressions present a high goodness coefficient, $R^2 = 0.9$. Model coefficients (with 95% confidence bounds) are: memory accuracy: $a = 3.9$ (2.9, 4.9), $b = 82.7$ (77.7, 87.8) and memory detail: $a = 0.3$ (0.2, 0.4), $b = 4.2$ (4.0, 4.4)

Nonlinear forgetting curves differ according to the distinctiveness value of the World Cup

From previous data we found that, overall, memory decayed linearly when the event was held prior to birth. Next, we examined the forgetting function of a specific World Cup to estimate the rate at which it will be forgotten from collective memory (see Roediger & DeSoto, 2014; Wixted, 2004). To achieve this

goal, memorability for a specific World Cup was fit to an exponential function ($y = ae^{bx}$). We assessed the forgetting curve over time for two different World Cups – 1982 and 1986 – using non-linear models of memory decay. We chose these two specific World Cups because they are close in time but their significance is very different: while in 1982 Argentina performed poorly, in 1986 Argentina won the championship with Maradona's superb performance. We calculated how long it

Fig. 4 Memory accuracy and memory detail for participants younger and older than 30 years for each FIFA World-Cup. Blue dots correspond to > 30-year-old subjects and black dots to < 30-year-old subjects. * One-way ANOVA corrected by Tukey's post hoc test, $p < 0.01$

takes for the curve to achieve a random choice level (20%), as an estimate of memory will be forgotten. These forgetting functions are shown in Fig. 5. The coefficients for the nonlinear regression for 1982 (with 95% confidence bounds) are $a = 80.1$ (68.3, 91.9) and $b = -0.04$ (-0.06, -0.01), whereas 1986 presents a slower decay, i.e., $a = 89.0$ (78.5, 99.4) and $b = -0.01$ (-0.03, 0.004). Thus, for the 1982 World Cup, the model takes 25 years to cross the random value, while for 1986 it takes 88 years to cross the random value.

As suggested by Roediger and DeSoto (2014) we can use these data to estimate the number of years that elapse before the memory for each World Cup accuracy falls to the random level (i.e., 20% accuracy). Notably, the 1982 World Cup would take 25 years to reach the random accuracy value, while the 1986 World Cup would take 88 years to fade.

Replication study

The replication study showed similar results to the main one, with a significant main effect of World-Cup tournament (Supplementary Fig. S2, repeated-measure MANOVA Wilks' $\lambda = 0.766$, $F(76,6308) = 5.720$, $p < 0.001$, $\eta_p^2 = 0.07$) on each dependent measure (Memory Accuracy, Memory Detail, Emotion, and Confidence) and a significant interaction between tournament and age (Tournament $\times$ Age interaction: Wilks' $\lambda = 0.850$, $F(76,6308) = 3.379$, $p < 0.001$, $\eta_p^2 = 0.04$). Moreover, we found the same peaks on each dependent variable around 1930, 1950, 1978, 1986, 1990, and 2014 corresponding to the tournaments in which Argentina played in the finals and the primacy, recency, and distinctiveness effect (Supplementary Fig. 2, Accuracy: RM-ANOVA $F(19.1577) = 7.267$, $p < 0.001$, $\eta_p^2 = 0.08$, Accuracy Tournament $\times$ Age Interaction $F(19.1577) = 2.664$, $p < 0.001$, $\eta_p^2 = 0.03$; Detail:

Fig. 5 Forgetting curves for 1982 and 1986 FIFA World Cups. Memory accuracy as a function of years elapsed for the 1982 tournament (light gray dots) and 1986 World Cup (dark gray dots). Forgetting was modelled with an exponential decay using nonlinear least squares (red line, $y = ae^{bx}$). For 1982 the model takes 25 years to cross the random value (20%) and for 1986 it takes 88 years to cross the random value (20%)

RM-ANOVA $F(19.1577) = 3.745$, $p < 0.001$, $\eta_p^2 = 0.04$, Detail Tournament $\times$ Age Interaction $F(19.1577) = 0.790$, $p < 0.001$, $\eta_p^2 = 0.03$; Emotion: RM-ANOVA $F(19.1577) = 9.553$, $p < 0.001$, $\eta_p^2 = 0.10$, Emotion Tournament $\times$ Age Interaction $F(19.1577) = 6.523$, $p < 0.001$, $\eta_p^2 = 0.07$; Confidence: RM-ANOVA $F(19.1577) = 13.855$, $p < 0.001$, $\eta_p^2 = 0.14$, Confidence Tournament $\times$ Age Interaction $F(19.1577) = 5.928$, $p < 0.001$, $\eta_p^2 = 0.07$).

General discussion

Collective memories are dynamic representations of a group's past, shared by their members. Thus, their history is built on and maintained by social representations, which influences the group's attitudes and behavior (Hirst & Manier, 2008; Nelson, 2003). There are many ways in which a collective memory can be acquired and maintained. In Western societies, school and other formal learning practices are responsible for transmitting the "official" version of their history to their group members. In addition to a common identity, these formal collective memories form a body of knowledge and schema templates that resemble some of the common findings in the individual memory literature (Hirst & Manier, 2008; Roediger & DeSoto, 2014). In contrast, informal learning occurs outside school, in a continuous unstructured manner in different ways (intentionally vs. incidental, experiential vs. cultural records, etc.; Eshach, 2007; Straka, 2005). More importantly, the transmission of this informal knowledge can be achieved through multiple channels, such as the media (radio, internet, newspaper, etc.), experience, social interaction, etc. In the current study, using a large sample of Argentinian participants, we investigated the individual memory of the FIFA World Cup (1930–2014) and provided evidence for the existence of a robust informal collective memory that shares common attributes with more formal collective memories such as the recall of presidents or wars (Fu, Xue, DeSoto, & Yuan, 2016; Zaromb et al., 2014). More specifically, we found evidence of general principles of individual memory in informal collective memories. Thus, these results suggest that the characteristics of collective memories may be independent of the conditions under which their acquisition occurs (formal/informal learning).

Although FIFA World Cups might seem inconsequential for a nation, sociological studies suggest that major international sports events shape national identity, nationalism, and social narratives (von Scheve et al., 2014). Football matches develop in contexts with national symbols such as flags, uniforms, and anthems. Furthermore, people group together in a stadium, public place, or in their houses to watch the games. Our findings revealed that the Argentinian memory for the FIFA World Cups transcends single games or a specific

tournament, and showed different common effects between individual and collective memories that are distinctive in formal collective memories.

Common effect 1: Serial position effect. Items in the first (primacy) and last (recency) positions are better recalled than items in other positions

Our results showed that the overall recognition memory (accuracy) was above chance and more accurate for the most recent FIFA tournaments, suggesting a recency effect. In addition, memory for the first World Cup (1930) was higher than the subsequent tournaments, thus suggesting a primacy effect. Similar findings were reported for the knowledge of US presidents and Chinese leaders (Fu et al., 2016; Roediger & DeSoto, 2014), where the most recent ones revealed a higher memory accuracy, thus showing that subjects within a community recall events in a similar way. In addition, we found that subjects were able to recall specific details for each FIFA tournament, but the number of keywords (details) were above the mean for the first and last tournaments, indicating both primacy and recency effects. Beyond the serial position effect, we found other peaks of recall (corresponding to 1930, 1978, 1986, 1990, and 2014) both in recognition and in detail memory, which correlated with Argentina's final position (playing or winning the final), supporting the idea that the importance and significance of an event influences its memorability (Rathbone et al., 2017; Rubin & Umanath, 2015). In addition, response confidence was associated with detail memory (Rubin & Talarico, 2017) but also with memory accuracy, suggesting a reliable memory. As expected, self-centered information (Argentinian position) was better recalled than that involving rivals (i.e., Brazil). Thus, this informal collective memory could be acquired or maintained in reference to the self and in consequence improve subsequent recall (self-reference effect; Klein & Kihlstrom, 1986).

Common effect 2: Internal and external factors are associated with memory-retention levels

Second, we showed that collective memory of the FIFA World Cup is associated with different internal and external factors such as subjects' emotion and general valuation for football. These factors followed a similar point-by-point trend to memory and there was also a positive correlation between them. In this sense, we found a strong association between these factors and both recognition and detail memory. In consequence, participants with a higher valuation for football and a higher emotional level had better recognition and detail memory. As predicted, the highest levels of emotion were associated with Argentina playing the finals. Football games are able to increase a subject's arousal and emotional states to

extreme levels. Different reports showed, for example, an increase in the number of myocardial infarctions, strokes, and testosterone levels during and after a FIFA World Cup match (Carroll, Ebrahim, Tilling, Macleod, & Smith, 2002; van der Meij et al., 2012; Wilbert-Lampen et al., 2008). These results are in line with other reports about memory and football. For example, Morris and colleagues (Morris, Gruneberg, Sykes, & Merrick, 1981; Morris, Tweedy, & Gruneberg, 1985) showed that football interest predicted subsequent learning of real and imaginary scores. Tinti et al. (2014) studied Italians' memory regarding their championship in 2010 as a form of flashbulb memory. They found that prior football knowledge was associated with better remembering and two pathways associated with vivid and detailed flashbulb memories: (1) valuation predicted emotional intensity and posterior rehearsal, and (2) valuation predicted media exposure and posterior response confidence. In our experimental design we were unable to analyze directionality or causation between memory measures and emotion as a predictor. However, our results as a whole are consistent with the idea that emotional value, general interest in football, and memory strength are associated.

Regarding the role of media exposure, it is important to consider a methodological limitation of our study. The quantity of information and media available is radically different for the earlier World Cups compared to the most recent ones. For example, there are 77,000 references in Google for the 1930 FIFA World Cup in Spanish, compared to the 18,300,000 for the 2018 tournament. Even more, it is difficult to assess the individual exposure to several sources of information (social media, TV, newspapers, etc.). Trying to bypass this limitation, we analyzed using Google Trends the number of searches made by Argentinians in the 2005–2019 period for the 1930, 1950, 1978, 1982, and 1986 FIFA World Cups (Supplementary Fig. S3). We found that periodically (every 4 years) the number of searches peaks around the World Cup months, reflecting an increase in interest and need for information. Google Trends analysis also revealed that in both 2014 and 2018 the most searched keyword in Argentina was “World Cup” (“Mundial,” in Spanish). Moreover, during the World Cup, TV content, the internet, and newspapers are all captured by football news and related images. It is an established fact that repeated retrieval or rehearsal of information leads to better individual recall (Forcato, Fernandez, & Pedreira, 2014; Roediger & Butler, 2011). Thus, our results suggest that knowledge and autobiographical recollection of the World Cups may be reinforced by media exposure. This periodical “social retrieval” of the World Cups may lead to better memory accuracy and richer details. In this sense, each new tournament contributes to a schema of the world-cups, which may help organize past events and facilitate the acquisition of new ones (Rubin & Umanath, 2015).

Common effect 3: Experienced events are better remembered than non-experienced events or those learned from alternative sources

Third, we revealed that participants' age at the time of each FIFA World Cup was critically associated with accurate recall, such as experienced events close in time were better recognized than those more distant (Holmes & Conway, 1999). Moreover, subjects were also able to recall more details for experienced than non-experienced events. This memory profile was correlated with a similar one for response confidence and emotion. Participants were more confident and emotional about those FIFA World Cups that they had experienced. Thus, we divided our population into two age groups: younger and older than 30 years. We found that from the 2002 World Cup the younger group reached the performance of the older group and even exceeded it in level of emotion and marginally in memory detail. This may suggest that more episodic memory is more persistent with the passage of time. Janssen and co-workers (Janssen, Rubin, & Conway, 2012) similarly found that preference for football players was those who reached the midpoint of their career when the participants were adolescents. Finally, as expected, we showed that one of the most memorable FIFA World Cups, such as the 1986 tournament where Argentina won the championship with Maradona's leadership, had a longer forgetting curve from collective memory.

Conclusion

Collective memories develop in the tension between the group and the individual. More than isolated pictures of a shared past, collective memories are stored as interrelated events with their own narratives and schemas, which in turn shapes a group identity (Coman, Brown, Koppel, & Hirst, 2009; Hirst et al., 2018). Importantly, a memory can only be considered collective if it is widely shared and if it helps to define and bind together a group (Brown, Kouri, & Hirst, 2012). Thus, in the present study we demonstrated that an informal shared knowledge acquired outside formal cultural practices, such as memory for the Football World Cup, represents a robust collective memory that is shaped by several factors. The similarity between informal and formal collective memories opens new venues in the understanding of how these memories are formed and maintained through different practices and channels.

Like other types of memory, collective memories are malleable and subject to change (Dudai, Karni, & Born, 2015; Nadel, Hupbach, Gomez, & Newman-Smith, 2012). In this sense, each generation could share a “common core” or theme for collective memories, although the significance attributed to the events may differ across generations (Rathbone et al., 2017; Roediger & Abel, 2015). In our study, this common

theme is Diego Maradona, the most mentioned keyword in memory detail (Supplementary Fig. S1), and also the organizer of the narrative for the 1978–2010 tournaments, where he was the coach of the Argentinian team. Traditional collective memory studies focused on public events, such as presidents with objective importance to a nation's past, which normally are acquired in classroom settings (i.e., Fu et al., 2016; Roediger & DeSoto, 2014; Zaromb et al., 2014). Here, using a football event, we showed how it forms a robust informal collective memory, which is only acquired by direct individual experience or media exposure. This suggests that any emotional or significant public event could potentially be transformed into an informal collective memory and contribute to a group identity similar to a more formal one.

All in all, here we showed that the FIFA World Cup constitutes a strong informal collective memory in a large group of Argentinean subjects, which is associated with different internal and external factors. Intrinsic features of the event (i.e., Argentina's final position), individual variables (i.e., age at the time of the event), emotional factors (valence), cognitive factors (valuation), and meta-cognitive factors (response-confidence) are essential for overall accuracy and details of a collective memory.

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Compliance with ethical standards

Open Practices Statements The datasets obtained in the current study are available from the corresponding author upon request. None of the experiments was pre-registered.

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