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# A Conceptual Replication of Survey Research on Study Strategies in a Diverse, Non-WEIRD Student Population

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In survey research from Western, educated, industrialized, rich, and democratic (WEIRD) populations, students report predominantly studying by rereading, highlighting, and summarizing, which are generally inefficient for long-term learning. It is unknown, however, whether, and to what extent, diversity, in the form of cultural context, socioeconomic status (SES), and sex, affect choice of study technique. In this exploratory study, we investigated the frequency of use of 10 common study strategies used by WEIRD students in a sample of respondents ($N = 795$) from a developing country (Brazil). We also examined if SES and sex influenced study choices. A similar pattern of study strategy preferences emerged for Brazilian compared to WEIRD students. The most popular study strategy for Brazilian students was rereading, followed by highlighting, summarizing, and doing practice problems. Study strategy preferences were not modulated by SES, whereas some small but significant sex differences were found. Our data show that interventions designed to improve academic success by teaching effective study strategies should reach all students, irrespective of cultural context and SES, but should consider possible sex-specific differences in strategy choices.

*Keywords:* socioeconomic status, gender, study strategies, culture, diversity



Choice of study strategy is critical for academic success (Credé & Kuncel, 2008; Geller et al., 2018) because some study techniques work better than others in terms of promoting lasting learning based on many criteria (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). To apply interventions to enhance study habits, it must first be established how people study to determine if there is room for improvement. This has been done almost exclusively in Western, educated, industrialized, rich, and democratic (WEIRD) student populations in the United States (U.S.; e.g., Karpicke, Butler, & Roediger, 2009).

Students frequently chose rereading material in these North American based studies. How-

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ever, a wealth of research has demonstrated that rereading is not an effective means of fostering long-term retention of information (Dunlosky et al., 2013; Rowland, 2014). It has been suggested that rereading is often used by students because it instills a feeling of competence associated with recognizing previously viewed content (Agarwal, Karpicke, Kang, Roediger, & McDermott, 2008; Koriat & Bjork, 2005). Students believe this familiarity with the content indicates that they know the material and that it will therefore be retrieved at will, such as during an exam (see Bjork, Dunlosky, & Kornell, 2013; Karpicke et al., 2009). The same applies when students study by redoing practice problems while having visual access to the solutions of the exercises. Consequently, familiarity misleads students by giving them an illusion of competence (Koriat & Bjork, 2005). This is pervasive even when students' grades do not confirm the efficiency of their choice of strategy (Hartwig & Dunlosky, 2012).

Today, there is a strong body of evidence that shows that people learn best by doing testing themselves (Roediger, 2013; Roediger & Karpicke, 2006b), or actively trying to retrieve information from memory with as few clues as possible about what is to be remembered. This way of studying is known as retrieval practice, which was also reported as a study technique in the aforementioned studies. This can be done by self-testing, such as answering quizzes or questions, thinking of previously studied content, writing down information from memory, and working through problems from scratch. Although rereading information can lead to equal or, at times, even better performance in the short term than practicing recall, the latter technique is more efficient in promoting long-term retention (Roediger & Karpicke, 2006b, 2006a). Through various neurocognitive mechanisms (van den Broek et al., 2016), retrieval practice also improves organization of information within memory, identification of gaps in knowledge, transfer of knowledge to new contexts, and learning from subsequent study (Roediger, Putnam, & Smith, 2011). Hence, apart from the illusion of competence instilled when rereading previously read content, focusing only on short-term retention may be another reason why rereading is a popular study strategy. Students may also avoid practicing recall because it involves more effort (Bjork et al., 2013) than rereading.

Passive learning techniques such as rereading or attending lectures are regarded as one of the best ways of studying not only by undergraduates, but also by lecturers, who have been found to recommend underlining or highlighting (McCabe, 2011; Morehead, Rhodes, & DeLozier, 2016; Rodrigues, Bu, & Min, 2000). Like rereading, these are ineffective techniques, as found in a large body of research data and criteria (Dunlosky et al., 2013). Admittedly, some teachers do suggest students practice retrieval, but, like students (see Kornell & Bjork, 2007; Morehead et al., 2016), they believe it is a good way of figuring out how well content has been learned rather than because it results in lasting learning.

Hence, absent information on how to learn more efficiently leads students to use the strategies they believe to be effective based on their own experience (Karpicke et al., 2009; Kornell & Bjork, 2007; see also Koriat & Bjork, 2005), which is hardly surprising since most report not having been taught how to study at all (Geller et al., 2018; Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007). It follows that students and teachers in the U.S. have little idea of which study techniques are the most effective for promoting long-term learning.

Given the metacognitive fallacies affecting our assessments of what we know, our tendency to seek easy ways of studying, and lack of adequate instructions from teachers, students must be taught how to make information "stick" based on scientific evidence (Pashler, McDaniel, Rohrer, & Bjork, 2008), so that their academic achievement is maximized (Brown, Roediger, & McDaniel, 2014). As mentioned, however, the literature on study technique preference is almost solely restricted to WEIRD samples, or North American students from elite universities (Carrier, 2003; Dunlosky et al., 2013; Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Kornell & Bjork, 2007; Rodrigues et al., 2000), where access to college is disproportionately high for students whose parents have high income (Chetty, Freidman, Saes, Turner, & Yagan, 2017). There are some data available on Italian children, who report favoring studying mostly by reading books and papers, but this study enquired about very few techniques (us-

ing texts, digital technologies, studying in group or alone; Poscia et al., 2015).

Hence, there is a dearth of knowledge on students' study strategies from more diverse, non-WEIRD samples such as students from developing nations, which are in dire need of improvement in educational outcomes. Establishing whether diversity affects study choices is important because WEIRD samples are the least representative population for generalizing how people behave in many respects (Henrich, Heine, & Norenzayan, 2010) and research in psychology should consider diversity (e.g., Klein et al., 2018; Rad, Martingano, & Ginges, 2018). Additionally, diversity is a hot topic in the field of education in countries such as the U.S. because of the growing variability among students in terms of racial, social, cultural, linguistic, and religious factors (Miller Dyce & Owusu-Ansah, 2016). This reflects the principles of the Incheon Declaration for Education 2030 (UNESCO, 2015), adopted by the United Nations Educational Scientific and Cultural Organization (UNESCO), United Nations Children's Fund (UNICEF), and the World Bank, among other important organizations. It posits that educational policies should address the uneven distribution of learning opportunities across countries, regions, and ethnic and socioeconomic groups, including schools/classrooms in which diversity is present, in order to drive development. Thus, diversity must be considered in studies that unite the fields of psychology and education, such as those that aim to understand how to improve learning opportunities.

Here, we studied the frequency of use of study techniques reported by students in Brazil, a country that sharply contrasts with WEIRD nations in terms of life expectancy, health, schooling, and standards of living and displays extreme socioeconomic disparity (United Nations Development Programme, 2016). Additionally, although Brazil is one of the world's leading economies (OECD, 2018), it is ranked very low on educational attainment, which is associated with a large poverty-stricken and under- or inadequately schooled portion of the population (OECD, 2017a). Our aim was to study whether there are differences in the patterns of choice of study habit in our and prior studies in U.S. samples. By contributing a Brazilian sample to the literature on study strategy preferences, we can better understand how educational interventions can help improve learning worldwide.

Why and how diversity can affect the way people choose to learn is still unclear, although some researchers have shown that diversity impacts study habits. A recent study has shown that many individuals from underrepresented minorities in the U.S. underutilize efficient study techniques such as self-testing and that this is associated with lower success rates in the fields of science, technology, engineering, and mathematics (STEM; Rodriguez, Rivas, Matsumura, Warschauer, & Sato, 2018). Rodriguez et al. (2018) conclude that these minorities are in need of guidance about how best to study, but offer no explanation for why they study inefficiently.

Although most students worldwide are used to being taught by lecturer-led instruction (Rodrigues, 2005), minorities may present cultural characteristics (see Hofstede, 2011) that can influence students' willingness to engage in some learning exercises and, therefore, in their effectiveness (Rodrigues, 2005; Rodrigues et al., 2000). Contributing to group discussions, for instance, is far more difficult for those from cultures high in uncertainty avoidance (with low tolerance to unstructured situations: see Hofstede, 2011) and high in power distance (with stronger hierarchy of authority, which present teacher-centered education: see Hofstede, 2011) if they regard themselves as of lower status (see Rodrigues, 2005). Hence, cultural dimension likely influences educational practices and people's choice of how to study. Indeed, Rodrigues (2005) stresses that there is no best study method fit for all when there is cultural diversity in the classroom.

Brazil, compared to the U.S., scores higher on cultural aspects such as power distance and uncertainty avoidance using the Hofstede scale (Hofstede, Hofstede, & Minkov, 2010), so, based on findings of Rodrigues et al. (2000) and Rodrigues (2005), it seems reasonable to consider that students from these cultures may have different preferences on how to study.

Alternatively, differences in how people study may not have to do with these cultural dimensions themselves, but instead reflect another factor that has been overlooked in this field, that is, socioeconomic status (SES), which is often confounded with culture, ethnic origin,

and low parental schooling (see below). Relating SES with how people study is important because there is a medium to strong positive correlation between SES and academic achievement (Sirin, 2005), irrespective of how well educational systems perform as a whole (OECD, 2017a). People from many ethnic minorities and from low SES families perform worse in almost all indicators of academic success, perpetuating inequality that has not narrowed in recent years (Zhao, 2016). This points to flaws in educational paradigms (Zhao, 2016) that are not only true when comparing people from different countries, but also within countries, including the U.S.

SES encompasses many material and nonmaterial factors such as education, income, job prestige, and neighborhood (Farah, 2017). Ideally, many of these characteristics should be considered jointly (Farah, 2017). When this is not feasible, one variable that is often used as a proxy of SES is parental schooling, which is associated with children's academic success (OECD, 2017a), cognitive performance, and brain functioning (Farah, 2017), all of which attest to the ability of this measure in discriminating among people's backgrounds. Another indicator of SES is quality of schooling of the individual themselves, which also impacts academic achievement (Farah, 2017). Lower quality schooling is associated with inadequate instructional materials and teacher-student ratios and lower teacher experience or effectiveness, which together show the effect of social capital on academic success (see Farah, 2017; Sirin, 2005). Hence, both lower parental schooling and inadequate schooling quality may lead students from lower income countries and/or lower SES to use less effective study techniques than their more privileged peers, irrespective of the country itself. Therefore, the effect of SES on choice of study technique was included in our analyses, even though prior studies from the U.S. on study techniques did not take this into account. This is at odds with the dramatic increase in income inequality over the past decades in the U.S. (Saez, 2018; Saez & Zucman, 2016). In the U.S., for instance, there is strong evidence that being born in a low-SES family has significant negative effects on neural development (e.g., Betancourt et al., 2016). Furthermore, low SES and poor health are highly associated, and together result in many long-term negative consequences for physical and cognitive development, as well as educational attainment in the U.S. (Bor, Cohen, & Galea, 2017).

Another factor that has not yet been investigated is the role of students' sex on how they study. This is surprising because female students consistently earn better grades than male students (Voyer & Voyer, 2014), which could have to do with their choice of learning strategy. After all, women and men differ in terms of academic self-efficacy, that is, in their belief in their ability to achieve intended results, which varies depending on the academic field or content domain (Huang, 2013): Women tend to have higher self-efficacy in areas such as languages and arts, while men do so in mathematics, technology, and social sciences. Self-efficacy beliefs interact with self-regulated learning processes, and mediate students' academic achievement (Zimmerman, 2000). Therefore, sex differences could impact how men and women decide to study. The only paper that analyzed whether sex influenced students' study habits was conducted in Italy and enquired about very few study strategies. It showed that women felt more pressure associated with grades and preferred studying alone and using printed rather than digital material (Poscia et al., 2015), so further information regarding how sex influences how students study is needed. Additionally, another indication that men and women differ in term of their experiences in school as that in the U.S., for example, although women have surpassed men in educational attainment in recent years, boys still seem to benefit more from higher quality schools than their female siblings in terms of reading and mathematics scores (Autor, Figlio, Karbownik, Roth, & Wasserman, 2016). Hence, in the present article we also considered possible differences in how students study differentiated by sex in our sample, a variable that was not explored in similar studies in the U.S.

To summarize, almost all studies on students' preference in learning strategies were conducted with WEIRD populations drawn from elite universities in the U.S., which did not explore the diversity of their participant samples, such as being from minority groups, foreign students, and their SES and sex. Results show that the use of inefficient techniques is rampant, and many authors have called for the need to alter this scenario by providing infor-

mation about how to study effectively (e.g., Karpicke et al., 2009). This is even more important in countries in which educational outcomes are poorer than those in the U.S. and in which the need for interventions that can help improve academic success and reduce educational inequities is dire (see UNESCO, 2015; Master, Meltzoff, & Lent, 2016), such as Brazil. To do so, it is necessary to carry out a conceptual replication on preference of study techniques in more diverse non-WEIRD contexts to analyze whether culture of origin, SES, and sex can influence students' study strategies, because designing adequate interventions may have to consider tailoring to fit particular characteristics of different types of students.

We investigated the use of study strategies that were reported as used by elite university students in the U.S. in a study published by Karpicke et al. (2009). These authors then grouped answers into 11 preferred study strategies, which were the following in order of preference: 1) rereading notes or textbook; 2) doing practice problems; 3) using flashcards; 4) rewriting notes; 5) studying in groups; 6) memorizing; 7) using mnemonics; 8) making outlines; 9) practicing recall (self-testing); 10) highlighting; and 11) thinking of real-life examples. Other studies also assessed use of similar strategies, but fewer ones. When asked to point out which strategies students used regularly, Hartwig and Dunlosky (2012) found similar results: Self-testing came first, followed closely by rereading content and using flashcards; recopying notes and making outlines were used less often; and highlighting and studying in groups were also mentioned as being used. Similar outcomes were found in additional studies with university students (Morehead et al., 2016), and also for middle-school and high-school students (Agarwal, D'Antonio, Roediger, McDermott, & McDaniel, 2014). All of these latter studies were conducted in the U.S. without considering possible variability in responses due to diversity in its many forms.

In the current exploratory study, we asked students from Brazil to report the frequency of use of study techniques that were reported by North American students in the study by Karpicke et al. (2009; see Table 1). We contrasted the pattern of general results to those obtained in samples from the U.S. to determine whether students from these countries study similarly or not. This comparison was descriptive because we enquired about frequency of use of the techniques while the U.S. based studies only listed the percentage of students who used each technique and their rank order of preference. We reasoned that frequency of use would give us a better picture of how much time per technique people were using instead of only having a metric that reflected order of preference. For instance, one student might use rereading 90% of the time and test him or herself the other 10% of the time, so self-testing would come second. Differently, someone may study by rereading 60% of the time and self-test the other 40%, in which case self-testing would also come second, but be used four times more often.

Our measures of SES were parental schooling (Erola, Jalonen, & Lehti, 2016; Farah, 2017; Sirin, 2005) and type of school attended (public, private, or a mix; see Voyer & Voyer, 2014), which, as explained above, are associated with academic success (see Farah, 2017; Sirin, 2005). Type of school, in particular, was assessed because, in Brazil, people of lower SES tend to go to public state schools, which usually offer poorer quality education compared to private institutions, in which those from higher income families are enrolled. These SES disparities probably partly reflect the strong association between school quality and educational outcomes (Autor et al., 2016).

Apart from listing study preferences in Brazilian students according to their SES, we also considered possible sex differences in choice of study strategies, due to the evidence that men and women approach studying differently (Huang, 2013; Poscia et al., 2015; Voyer & Voyer, 2014; Zimmerman, 2000).

We hypothesized that lower social capital, such as being from a non-WEIRD country, with high variability in SES and low school quality indicators, would negatively influence choice of study habits compared to students in the U.S. Within our sample, we also believed that higher SES would be associated with the use of better techniques because of better access to information, going to higher quality schools, and having higher academic achievement. We also expected to find differences in study strategies between men and women because their academic success and feelings regarding learning efficacy are distinguishable, but we could not anticipate exactly which differences, because no

Table 1
*Percentage of Participants Who Reported Frequency of Use of 10 Study Techniques, Mean Scores per Technique, and Order of Preference of Use by Sex for the Brazilian Sample*

| Study technique/strategy[a] | Utility[b] | Frequency of use of technique | | | | | Mean scores (±*SD*) | Order of frequency of use (men) | Order of frequency of use (women) |
|---|---|---|---|---|---|---|---|---|---|
| | | Never (score 0) | No longer (score 1) | Rarely (score 2) | Sometimes (score 3) | Frequently (score 4) | | | |
| Rereading notes/textbook | Low | 1 | 1 | 4 | 27 | 67 | 3.59 ± .68 | First | First |
| Doing practice problems/exercise | High | 1 | 2 | 10 | 32 | 55 | 3.39 ± .82 | Second | Third |
| Highlighting text/notes | Low | 3 | 6 | 8 | 18 | 64 | 3.35 ± 1.05 | Sixth | Second |
| Summarizing | Low | 3 | 6 | 10 | 26 | 55 | 3.24 ± 1.06 | Fifth | Fourth |
| Practicing recall (self-testing) | High | 3 | 7 | 14 | 33 | 43 | 3.07 ± 1.04 | Third | Sixth |
| Thinking of real-life examples | Moderate | 7 | 5 | 13 | 25 | 50 | 3.06 ± 1.20 | Fourth | Fifth |
| Rewriting notes | Low | 9 | 8 | 24 | 26 | 34 | 2.67 ± 1.27 | Seventh | Seventh |
| Memorizing | Low | 6 | 19 | 21 | 32 | 22 | 2.45 ± 1.19 | Eighth | Eighth |
| Mnemonics (e.g. acronyms) | Low | 17 | 15 | 20 | 27 | 21 | 2.20 ± 1.38 | Ninth | Ninth |
| Studying in group | Low | 21 | 25 | 30 | 18 | 6 | 1.63 ± 1.18 | 10th | 10th |

[a] Study strategies were those listed in Karpicke, et al. (2009), who asked students to rank strategies used (use of flashcards was not included because this technique is largely unknown in Brazil) and did not include information on participants' sex. Unlike Karpicke et al.'s (2009) study, we had students rate how often they used each strategy on 5-point scales. [b] Utility of study technique to promote lasting learning based on Dunlosky, et al. (2013). "Thinking of real life examples" was considered "explaining how new information is related to known information"; memorization is not explicitly addressed in their publication, but implied to be low.

prior study has described, separately, how men and women study.

## Method

### Participants

The sample was composed of 795 Brazilian students who were preparing for university entrance examinations (precollege students) and who completed an online questionnaire (developed using PHP programming language and MySQL database) that enquired about demographics and study habits over a three-month period.

### Procedure

The study received ethical approval from the Ethics Committee of Universidade Federal de São Paulo in Brazil. Participants were recruited through social media, school programs, and press releases. All students provided informed consent to allow use of their data for research purposes. As per Brazilian ethical guidelines, they were not compensated in any way for taking part in the study. Participation involved filling out an online questionnaire that included items on a) demographics (age, sex, academic area of interest [biological sciences, exact sciences, humanities], parental levels of schooling [based on the Brazilian educational systems: see Table 2], and type of school attended [only private, only public, mostly private, mostly public]); and b) study habits by asking for information on use of 10 of the 11 study techniques listed by Karpicke's et al. (2009): rereading notes/textbook, practice problems/exercises, highlighting text/notes, summarizing, practicing recall, thinking of real life examples, rewriting notes, memorizing, mnemonics, and studying in group. We did not enquire about use of flashcards, the 11th strategy, because a pilot study showed that this way of studying was virtually unknown in this country.

Unlike Karpicke et al. (2009), who determined percentage of students who reported using each technique and rank order of use of these techniques, which says little about how often each student uses different ways of studying, here students were asked to reported the frequency of use of the techniques listed by Karpicke et al. (2009) using a 5-point Likert scale (*never used this technique* = 0; *used it in the past but no longer do so* = 1; *rarely use this technique* = 2; *sometimes use this technique* = 3; *frequently use this technique* = 4). Other information (e.g., chronotype, stress level) was also obtained from this sample and will be reported elsewhere. This project was registered in the Open Science Framework (OSF). Addi-

Table 2
*Distribution of Years of Education of Parents/Guardians (Proxy for Socioeconomic Status) of the Sample of Students (n = 795) According to the Brazilian Educational System*

| Schooling level/description | Father (no.) | Mother (no.) |
|---|---|---|
| No schooling | 22 | 13 |
| 1–3 years (did not complete elementary school) | 88 | 74 |
| 4 years (completed elementary school) | 39 | 32 |
| 5–7 years (did not complete middle school) | 66 | 54 |
| 8 years (completed middle school) | 45 | 40 |
| 9–10 years (did not complete high school) | 85 | 69 |
| 11 years (completed high school) | 208 | 229 |
| 12–14 years (did not complete college/university) | 37 | 53 |
| 15 years (completed college/university) | 146 | 161 |
| 16–17 years (specialization or master's degree) | 30 | 67 |
| 18 or more years (PhD or higher) | 1 | 2 |
| Missing data | 28 | 1 |

*Note*. Years of education in Brazil have different educational stages than in the U.S.: 4 years of "elementary school," 4 years of "middle school," 3 years of "high school"; usually 4 years of college or university, 2 years for specialization or master's degrees, and 4 years for PhD.

tional materials are available on OSF at (https://osf.io/cfhyu/).

### Statistical Analysis

Descriptive statistics were expressed as sample sizes (*N*), means, and standard deviations. Scores of frequency of use of each of the 10 study technique (dependent variables) were analyzed with a general linear model (GLM) using Statistica Software v.10 with the following factors: type of study technique as a within-participant factor (10 levels, one for each of the surveyed technique), sex, and type of school (four levels: public, private, mostly private, and mostly public) as between-participants categorical predictors, and parents' or guardians' mean educational level (as per the Brazilian educational system; see Table 2) as a continuous predictor. Normality of residuals of each statistical model was confirmed. Post hoc analyses were conducted with Tukey honest significant difference tests for groups of different sizes, which correct for multiple comparisons. The adopted level of significance was $p < .05$. The syntax is available at OSF [https://osf.io/cfhyu/].

## Results

We analyzed data from 795 students (542 women: 68%) aged 20.1 ± 5.6 (mean ± *SD*) who filled in the questionnaire during a three-month period. Based on the stratification of subject areas in Brazil, most had interests in the fields of biological sciences (women $N = 322$, men $N = 111$), followed by humanities (women $N = 132$, men $N = 64$) and exact sciences (women $N = 50$, men $N = 59$; missing data: $N = 57$). The sample varied widely in terms of SES. Parental education ranged from zero (no years of education) to PhD (mean parental years of education ± *SD*: 5.4 ± 2.2; equivalent to 9–10 years; see Table 2). Most participants had attended only public schools ($n = 438$), while 208 had attended only private schools; the remainder had studied in both types of schools (more public than private, $n = 82$; more private than public, $n = 67$).

In our GLM, the SES factors (parental levels of education and type of school attended) were not significant and did not interact with the other factors ($p$ values $> .08$), suggesting that social privileges are not associated with better choice of how to study. Differently, the effect of study technique was significant, showing that students indeed prefer some strategies to others [$F(9, 6984) = 29.48$; $p < .0001$; $\eta_p^2 = 0.037$; Table 1]. The most to the least frequently used study strategies were (all post hoc Tukey's test values for differences: $p < .04$) the following: 1) rereading content, which was more used than all other techniques; 2) doing practice exercises, highlighting text and summarizing, which were undistinguishable among each other and more used than the other techniques except rereading; 3) thinking about real life examples, less used than the former four mentioned techniques and more used than those mentioned next; 4) self-testing/practicing recall, less used than the former and more used than the next ones; 5) rewriting content, less used than the former and more used than the next; 6) memorizing, less used than the former and more used than the next; and 7) mnemonics, less used than the former and more used than studying in groups, which was the least used technique.

Sex was also a significant predictor [$F(1, 776) = 8.80$; $p < .003$; $\eta_p^2 = 0.011$], with women having reported higher frequency of technique use overall. This was due to sex differences in the use of some specific techniques, evidenced by the interaction of study technique and sex [$F(9, 6984) = 4.02$, $p < .0001$; $\eta_p^2 = 0.005$; Figure 1]. As this post hoc analysis included many contrasts, we focused on absolute differences in frequency of use in men and women for the same technique and also onthe difference among techniques in the same sex. Women highlighted text, summarized class material, and used mnemonics more often than men (post hoc $p$ values $< .04$). The values of multiple $R^2$ for the techniques that differed between men and women varied: It was much higher for highlighting ($R^2 = .116$) than summarizing ($R^2 = .046$) and mnemonics ($R^2 = .030$), but these effects only reached small effect sizes. The order of preference of techniques also differed within sexes. For women, the frequency of use from highest to lowest was (all of which were significantly different except for those specified next, $p < .02$): rereading equaled highlighting and doing practice problems, which were all used more frequently than summarizing,followed by thinking of real world examples, which equaled practicing recall, followed next by rewriting; memorizing, which was used as often as mnemonics; and, last of all,

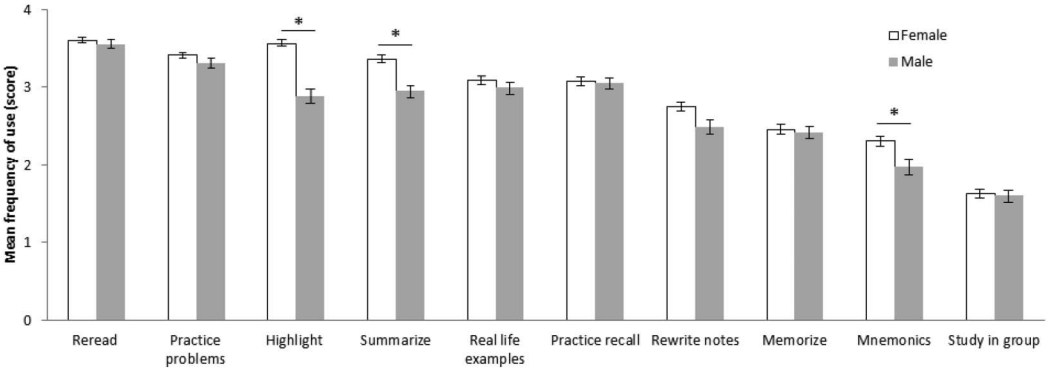


*Figure 1.* Mean (±*SE*) frequency of use of the 10 listed study techniques, according to sex (no. men = 253; no. women = 542). There was an interaction of technique and sex. * Differences between sexes when comparing the same technique (*post hoc p* values < .006). For comparisons between techniques in each sex, see Table 2. Frequency of use were rated as: 0 = never used this technique; 1 = have used this technique but no longer do so; 2 = rarely use this technique; 3 = sometimes use this technique; 4 = frequently use this technique.

studying in groups. For men, the order was (*p*s < .004) the following: rereading equaled doing practice problems; doing practice problems equaled practicing recall and thinking of real-world examples, the latter of which equaled summarizing and highlighting, all of which were used more than rewriting, which equaled memorizing, followed by mnemonics and, last, studying in group.

## Discussion

It has been well established that students in the U.S. often use ineffective study strategies such as rereading (see Karpicke et al., 2009), but little is known about how diversity affects study habits. In the present conceptual replication study, we showed that, similarly to students from the U.S., Brazilians favor ineffective study techniques and that SES did not interact with frequency of use of study strategy, contrarily to our hypotheses. Sex, on the other hand, influenced preferences in terms of 3 of the 10 investigated techniques (low effect sizes), showing that men and women can approach studying slightly differently. Overall, students in both countries, despite their differences, seem to be similarly wasting a lot of their time in studying inadequately. Next, we will contrast our results with those obtained in prior U.S. studies for each surveyed technique, with the aim of showing that it is difficult to claim that the Brazilian students who participated in this study have worse study habits even though they differ in cultural and SES respects from samples in the U.S.

The most frequent way of studying reported by Brazilian precollege students was rereading texts and notes, which is not regarded as an efficient learning technique (Dunlosky et al., 2013; Rowland, 2014). The high popularity of this way of studying was also found in college students in many publications from the U.S. (Carrier, 2003; Hartwig & Dunlosky, 2012; Karpicke et al., 2009; see also Dunlosky et al., 2013; Geller et al., 2018; Morehead et al., 2016) and one study in Italy (Poscia et al., 2015). After rereading, the next three most popular techniques reported by our sample (doing practice problems, summarizing, and highlighting) were undistinguishable from each other. Although doing practice problems/exercises, which involves retrieval practice, was also the second most popular technique reported in the study by Karpicke et al. (2009), it was reported by 42% of their sample, while 99% of the Brazilian students claimed to use this technique with varying frequency. We can only speculate on the reasons for this. Data from Hartwig and Dunlosky (2012) and Morehead et al. (2016) do not help because they surveyed "using practice problems or self-testing" jointly, whereas Karpicke et al. (2009) and our study surveyed them independently. One possibility is that this

may have stemmed from the characteristics of the samples regarding academic areas of interest. The majority of our sample reported interest in the field of biology, and it has been shown that students in STEM fields solve a lot of practice problems as a way of studying (De Camargo, Oliveira, Rodriguez-Añez, Hino, & Reis, 2013; Rodriguez et al., 2018). Karpicke et al. (2009), however, did not report the area of interest of the participants in their study, so we cannot confirm this hypothesis. These results show that it may be important to determine if students from different academic areas study differently, something that has not been addressed in prior investigations. The present study was not designed to take this into account, and the uneven number of students interested in each of the academic areas and their distribution by sex precluded an analysis of this factor.

Highlighting, on the other hand, was frequently mentioned here and in Hartwig and Dunlosky's (2012) and Morehead et al.'s (2016) samples, but seldom in Karpicke et al.'s (2009) study. This difference among these investigations may reflect different proportions of men and women in the surveyed samples. Like ours, previous studies included fewer men than women, who we here found to use highlighting more often. This could have led this technique to be reported as used as often as doing practice problems in the sample as a whole. We cannot confirm this suggestion because Karpicke et al. (2009) did not report the sex of their participants, and Hartwig and Dunlosky's (2012) and Morehead et al.'s (2016) studies, which included a similar proportion of men and women as the present study (around 30% to 70%, respectively), did not analyze sex effects. However, we can speculate that if Karpicke et al.'s (2009) sample was composed of fewer women than men, this could also explain why summarizing material (making outlines) was rank ordered much lower in their survey, as this technique was also found to be used more frequently by women in the present study. These findings point to the importance of analyzing sex differences in the use of study techniques, which was not analyzed in published papers in this field. The finding that female students highlight and summarize more often indicates they are more likely to study in nonoptimal ways, because Hartwig and Dunlosky (2012) found that making outlines was negatively related to test outcomes, although frequency of highlighting was not associated with test scores. In this respect, differently from what was found for use of practice problems, higher reports of highlighting would indicate a worse way of studying compared to Karpicke et al.'s (2009) study, but not of those by Hartwig and Dunlosky (2012) and Morehead et al. (2016).

Some studies show that students can vary in how effectively they use each technique (Hartwig & Dunlosky, 2012), something that neither the U.S. studies that investigated study methods, nor ours, assessed. It is therefore possible that although women use some technique that are generally deemed inefficient more often than men, they may do so more effectively. According to Dunlosky et al. (2013), for instance, highlighting can lead to adequate retention of academic content if carried out by students with more domain knowledge. Therefore, further attention must be given to whether and/or to what extent different patterns of study choices and how students use each technique across sexes relate to better grades in female students (Voyer & Voyer, 2014), or sex differences in academic self-efficacy (Huang, 2013).

The next most frequently used strategies by Brazilian students were thinking about real life examples, regarded as being of moderate utility, and self-testing, one of the best ways of studying (Dunlosky et al., 2013). As both of these strategies were ranked low in Karpicke et al.'s (2009) paper, this suggest that Brazilian students use part of their study time more effectively. Again, it is possible that this was due to our sample having included a majority of students with interest in STEM areas, who use retrieval practice frequently (Rodriguez et al., 2018).

About half the North American students surveyed by Hartwig and Dunlosky (2012) and Morehead et al. (2016) reported studying with peers, whereas this was the least used strategy of all in our study and in Karpicke et al.'s U.S. sample, mirroring the avoidance of this technique by Italian students (Poscia et al., 2015). Collaborative problem solving is above average in the U.S. but below average in Brazil and Italy (OECD, 2017b), so these differences could reflect a negative cultural approach to working in groups. However, this must be further studied as it cannot explain why students in Karpicke et al.'s (2009) U.S. study reported infrequent

group studying. Notwithstanding, collaborative learning as a study strategy has been found to be negatively related to grades (see Hartwig & Dunlosky, 2012), suggesting that our Brazilian sample is not at a disadvantage in avoiding doing so. The same can be said about rewriting content, memorizing, or using mnemonics, all of which are considered low-utility techniques in the literature (Dunlosky et al., 2013) and were reported as rarely used by our sample, in contrast to results of Karpicke et al. (2009).

Overall, irrespective of the diversity within our sample and its difference to that of the WEIRD populations used in similar studies in North America, likely from higher SES because institutions in the U.S. tend to include a disproportional number of higher class individuals (Chetty et al., 2017), the data hardly show that being Brazilian or from a low SES is associated with use of less-efficient study techniques. Furthermore, the samples analyzed by Hartwig and Dunlosky (2012); Karpicke et al. (2009), and Morehead et al. (2016) were older and had more years of schooling than our participants, and these characteristics also failed to lead them to choose better ways of studying. Hence, higher SES is unlikely to protect students from studying inadequately, and cultural context seems to have little to do with the common use of inadequate study strategies. Nonetheless, Brazil and the U.S. are both Western cultures, so how students from other parts of the world study remains to be investigated.

Considering the high prevalence of use of ineffective study techniques in Brazil and in the U.S., lack of information on how to study seems widespread, as many experts have noted in the developed world (Bjork et al., 2013; Dunlosky et al., 2013; Karpicke et al., 2009; McCabe, 2011). Students are seldom taught about the efficacy of different learning strategies (Geller et al., 2018; Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007), and the teachers who give advice on how to study do not use recommendations based on scientific evidence (Geller et al., 2018; Kornell & Bjork, 2007). It may be that the same metacognitive fallacies that drive these habits, such as the illusion of competence (Karpicke et al., 2009; Koriat & Bjork, 2005; Kornell & Bjork, 2007), are at play in diverse contexts.

To conclude, unlike studies run in the U.S. (Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Morehead et al., 2016), which determined the percentage of students who used various technique and/or the order of preference of these ways of studying (rank order), in the present conceptual replication study we investigated the frequency of use of study techniques listed by Karpicke et al. (2009), in a more diverse sample of Brazilian students. We thus contribute to the literature by having enquired in more detail about how often each study strategy was employed, in addition to investigating this issue in a non-WEIRD sample and how SES and sex affect choice of study strategies. This exploratory study is important because, even in the U.S., teachers have to deal with social, economic, and ethnic diversity in the classroom (Bowman, 2010; Miller Dyce & Owusu-Ansah, 2016), which seem to be on the increase (Saez, 2018; Saez & Zucman, 2016). Moreover, WEIRD populations represent only a small portion of humanity (Henrich et al., 2010), which justifies the need to replicate results of studies carried out in WEIRD countries in other types of samples (Klein et al., 2018). We found that students who have completed high school in these Western cultures seem to be wasting a lot of their study time by using inefficient techniques, irrespective of their SES. Female students may be more at risk of doing so, as they reported highlighting more often than men, as well as summarizing and using mnemonics more frequently, although the latter two effects were of very small effect sizes. However, they may be more skilled at using these methods, a factor that we, and the studies in the U.S. that involved similar surveys, did not assess. Therefore, further research is required to gather more detailed information on how students of different sexes and from varying cultures and SES use each learning strategy and how these habits translate into grades (see Hartwig & Dunlosky, 2012).

Our study is limited in some respects. We descriptively contrasted our data with similar studies, which did not directly determine frequency of use of study techniques. By including only precollege students, despite the wide variability in SES, our sample was biased regarding very low SES individuals, most of whom do not complete high school in Brazil and are therefore not eligible to apply to a university. The ones who do can be regarded as "resilient" students, that is, those who have beaten the odds stacked

against them (see Agasisti, Avvisati, Borgonovi, & Longobardi, 2018) by completing school. They therefore do not represent their low-SES peers. These students may have managed to achieve better levels of education precisely because they developed better study strategies, so more research is required to understand how very low SES affects use of study strategies in those who fail to finish high school. Ethical guidelines in this country also precluded us from accessing students' grades, which could have shown an association between academic achievement and choice of strategy. Notwithstanding, results from this study and others on study techniques used in the U.S. suggest there is plenty of room for improving academic performance worldwide, although this must be confirmed in similar surveys in other cultural contexts, such as in Eastern nations. One way of improving study habits is to incorporate more retrieval practice and other learning techniques that have been scientifically proven to be effective. To do so, students and educators must be shown why these techniques work (Agarwal & Bain, 2019; Tovar-Moll & Lent, 2016) and how to implement them (see Agarwal, Bain, & Chamberlain, 2012; Bjork et al., 2013; Dunlosky et al., 2013; Putnam, Sungkhasettee, & Roediger, 2016). This may help reduce educational inequities internationally (see Master et al., 2016; UNESCO, 2015; Zhao, 2016). In this sense, we agree with Roediger and Pyc (2012), who argue that many of these techniques are easy to use, are not costly, do not involve modifications in the content that is to be taught per se, and only require minor changes in time spent on teaching and studying.



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