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Learning the psychology of the tip-of-the-tongue phenomenon through on-line practice

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Abstract

Psychology undergraduates can benefit from direct experiences with laboratory procedures of psychological phenomena. However, they are not always available for students within a distance education program. The present study included students from the Spanish National Distance Education University (UNED) that were to take part in a Basic Psychology examination session. They participated in web-sessions on a tip-of-the-tongue (TOT) laboratory procedure. The aim was to study whether their performance at TOT-related items would be differentially improved. Our results support the conclusion that practicing with the TOT application was effective in improving the TOT comprehension among students. Study A showed that the performance level was higher for the TOT-practiced participants relative to the non-practiced ones. Study B showed significant group by item-type interaction. Also, there was a significant effect of group, and item-type. The results are contextualized in the psychological institutions' mainstream effort for Psychology to be viewed as a STEM discipline by students, the political representatives, and the society.

Keywords: Distance education; e-learning; scientific psychology; folk psychology; tip-of-the-tongue; STEM

Introduction

Direct experience of psychology students with the research procedure of psychological phenomena is usually considered a very profitable strategy for Psychology undergraduates. Typically, the course strategy includes presenting students with psychological phenomena and supporting the presentation with how researchers undertake its study under scientifically controlled conditions (e.g., Homa et al., 2013). A similar schema seems to be very often at work in the introductory psychology textbooks (Benjamin, 2005; Griggs & Bates, 2014). However, as Norcross et al. (2016) have pointed out, only a 3% of undergraduate Psychology programs offered a lab for their introductory course. Yet, according to Goal 2 of the *APA Guidelines for the Undergraduate Psychology Major version 2.0*, even "students completing foundation-level courses should learn basic skills and concepts in interpreting behavior, studying research, and applying research design principles to drawing conclusions about psychological phenomena" (APA, 2013, p. 20). Furthermore, very few works have studied learning after running experiments by measuring exam performance (Gil-Gómez de Liaño, León & Pascual-Ezama, 2012).

With that goal in mind, for ordinary psychology courses, the benefits of engaging students in a teacher-monitored immersion within a psychological research procedure are well-known (e.g., Gurung et al., 2016; Pearson & Richardson, 2013). However, for distance education institutions, most of the learning tasks are usually self-guided; and, very often, no specific tutoring is available at the exact moment when the student starts studying a certain psychological topic. For instance, in our institution, the course materials are available through the Internet (as hypertext or pdf documents), and students can use them without any constraining external timing and without interactive personal tutoring; yet, personal tutoring is supposed to be given on demand (Luzón & Quintana, 2010). Therefore, the

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question arises as to whether the open availability through the Internet of a psychological research procedure improves the understanding of its targeted psychological phenomenon.

Following a suggestion by Moore (1989; see also the *Community of Inquiry* framework described by Garrison & Akyol, 2009), Bernard et al. (2009) conducted a meta-analysis of the instructional power for students in a distance education context of three types of factors: interactions with the course material (e.g., Hartnett, 2013), interactions with other students (e.g., Thoms & Eryilmaz, 2014), and interactions with their teachers (e.g., Coll, Rochera & de Gispert, 2014). Unsurprisingly, they found that, overall, the most beneficial interaction was that with the course material. Consequently, a very appropriate way to improve psychological learning seems to be the intensification of the contacts between the student and the to-be-learned psychological subject. Yet, the relevance of multi-media as tools for achieving a reliable understanding of concepts and phenomena has been emphasized (e.g., Mayer, 2001). In fact, this view seems to be particularly suited for engineering, experimental sciences, and mathematics, because, with the help of videos and software applications, seemingly intricate concepts and principles can become perfectly understandable (e.g. Zhang, 2014).

Although students are presented with Psychology as an experimental science (Breckler, 2014a), there is something peculiar to the everyday psychological processes that hampers their scientific understanding by undergraduates in an introductory psychology course. Certainly, the misconceptions and ordinary first-person experience with the phenomenon very often gives rise to the fact that a considerable effort is required to change the view to a more educated, science-bound, third-person analysis (for a review, see Hughes, Lyddy & Lambe, 2013). To overcome these difficulties, associated as they are to everyday psychological processes, a closer acquaintance with their research procedures appears as important as it seems to be for any other natural phenomenon. Let us take as an example the so-called *tip-of-the tongue* (TOT) phenomenon. For a layperson, this is just a matter of not remembering something at the precise moment we need it, while, at the same time, being completely sure we know/remember it very well. But, for psychologists, the TOT phenomenon has been, for decades, a window to the very complex mechanisms of language and memory (see, e.g., Koriat & Lieblich, 1974; for a review, see Dunlosky & Metcalfe, 2009; Ruiz, 2003, 2004). However, its replication in the laboratory, under controlled conditions, has been anything but an easy task. Overall, these peculiarities make the TOT research procedure a very appropriate tool to illustrate, at an Introductory Psychology level, the main features of scientific psychological inquiries.

Going back to our general question, we could re-frame it as whether the availability through the Internet of the TOT research procedure could improve the understanding of its methodological and theoretical intricacies by those enrolled in an online introductory psychology course. To answer this question, related with the interdependence between instructional contexts and levels of performance that could influence student achievement (De la Fuente, Martínez, Peralta & García, 2010), we ran two studies on the usefulness of online psychological procedures delivered as practices in an ongoing Psychology course.

In the studies described below, some of the students that were to take part in a Basic Psychology examination session voluntarily applied to participate in web-sessions on a typical TOT procedure. The TOT phenomenon and the way it was studied by experimental psychologists were course topics. Yet, the practice itself was defined from the beginning of the term as an assignment. As a consequence, 6 out of the 30 items in the exam were about the TOT practice. We wanted to know whether the participation in the internet practice sessions would improve the examinees' performance at the TOT-related items above that of the non-participants, compared to their achievements in the non-related items. An improvement in the average results on the target test-items would mean that the internet facility used was appropriate as a tool for the understanding of the TOT phenomenon and for learning how psychologists perform their laboratory research on it.

As there were two examination sessions and the students could freely choose just one of them, we describe the data as *study A* and *study B*. Every multiple choice, 30-item test was completely independent from each other and both were prepared by the teachers well in advance of the sessions. The assignment of either test to a session was random.

Study A

Method

Participants

The data for this study were obtained from the 64 students who took part in the first examination session of a four-month Basic Psychology course. The course was mandatory in the Social Work Degree at the *Universidad Nacional de Educación a Distancia* (UNED). The task was a voluntary assignment for the course. The participants were 46 women and 21 men, aged between 21 and 53 years (Mean=34, *SD*=9.1). As described below, 34 of these students voluntarily applied for the participation in at least one web session of the available TOT procedure.

Materials

The course lessons and reading assignments were available to the students as pdf documents. They were accessible on the Internet through *aLF*, an e-learning platform designed by the UNED's staff for their undergraduate students (e.g. Luzon & Quintana, 2010). Within these materials, a chapter about the psychology of memory (Ruiz, 2011) included a description of the TOT phenomenon, along with some topics on its relevance for human memory understanding. The difficulties for the production of the TOT phenomenon under controlled conditions were emphasized.

Additionally, all throughout the course-term, two practice Internet pages were accessible in aLF, each one with a short presentation of an Internet application for practicing with both an attentional procedure and the TOT. Each of them included a link to a pdf document with more detailed specific instructions (i.e., user's guide) about how to work with the procedure (Contreras, 2010; Ruiz, 2010). The TOT aLF page also included a link to a Java applet that controlled a version of the TOT laboratory procedure by Koriat and Lieblich (1974). The Spanish stimulus material for the application was taken from González (1996). The applet was a menu-driven application with a task menu to freely select: (a) a few individual practice trials, (b) the whole individual experimental session, (c) a few collective practice trials, and (d) the whole collective experimental session. In addition to the task menu, there was a help menu that offered extensive and detailed on-line help for the user as conductor of the experiment, and a page for downloading the instructions given to TOT-participants, both for the individual and the collective versions of the TOT procedure; there was also a response sheet for the collective version of the TOT procedure[1] available to download. See Figure 1 for a screenshot of a trial of the TOT procedure.

[1]A JavaScript version of the TOT application is now available from the Internet at http://www.prolepsis.es/TeleTest/EPL. Also, the accompanying user's guides and other related documentation are available upon request from the first author

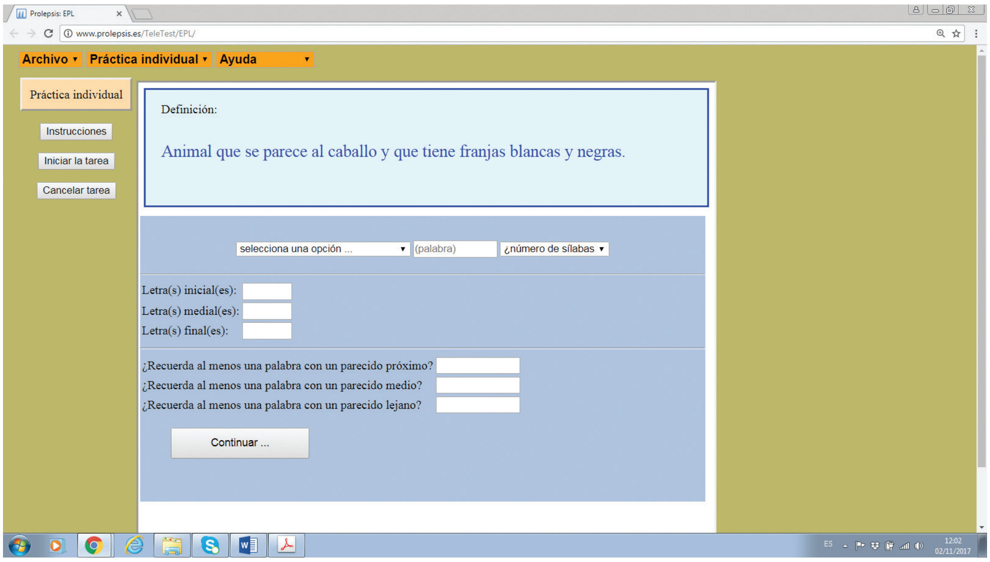

Figure 1: Screenshot of a trial of the TOT procedure

For the qualification exam on the *Basic Psychological Processes* program, the usual 30-item test was presented. The questions were three-alternative items, one of them correct; and there was no penalty for omissions, although a false choice yielded a penalty of half a point/score, which was deducted from total number of hits. Students were well acquainted with this kind of qualification exams, as they are very common at our university. According to the university schedules, the items were prepared about two months before the exam session. Six out of the 30 items were target or experimental items, because they dealt with the TOT practice. The other 24 items were common questions about the remaining course material. Due to a composition error in one of the target items, it was excluded from the analyses.

Procedure

From the beginning of the course, students were encouraged by the teachers to carefully study the course-materials, to participate in the aLF forums discussions, and to engage as carefully as possible in the practice applications. Yet, they knew from the general information about the course that up to 25% of the items in the exam could be about the practice materials. The practice applications were available at any time through the aLF platform. Whenever a student tried to freely start the TOT procedure, s/he was required to enter her/his identity card number and last name to run the TOT application. The applet controlled stimuli presentation and response recording, and sent every student's response to a *php* script, in order for the script to appropriately record the events in a database, along with its time of occurrence and participant's data.

The exam session lasted for 120 minutes and took place within the ordinary university settings and facilities scheduled for the degree qualification exams. The exam was a paper-and-pencil three-choice test. During the exam, students were allowed to use whatever printed material they wanted; although sharing them or the use of digital media were forbidden by the exam supervisors.

The R software was used for the filtering, tabulation and statistical analyses all through the paper (R Core Team, 2013).

Results

Data corresponding to any practice session performed after 24:00 of the night before the exam were filtered out of the database. Participants that took the degree exam were classified in two groups as a between-subjects factor: those that entered the practice session at least once before this virtual deadline, and those who did not. Also, the type of item was a within-subject variable in the design: target TOT-related items and non-target TOT-unrelated items.

In order to analyze the effect of practicing with the application on the TOT-procedure understanding, we first ran an ANOVA on the hit rates in both kinds of items for the two groups of participants. Table 1 shows the mean hit rates for the two types of items and for both the practiced and the unpracticed group. It can be observed that performance level was higher for the TOT-practiced participants relative to the non-practiced ones, $F(1,62) = 26.45$, $MSE=2.34$, $p<0.05$, $\eta^2= 0.16$. Also, it can be seen that students performed better at the non-TOT contents of the course, since the mean hit rates for the non-target items was higher than for the target items, $F(1,62) = 115.12$, $MSE=0.54$, $p<0.05$, $\eta^2= 0.50$. The target-items performance level decreased up to about 1/5th (.11/.56) of the non-target ones for the unpracticed group, while this relation was only 1/2 (.35/.67) for the practiced group. Yet, this interaction, although expected from our hypothesis, just approached significance, $F(1,62) = 2.98$, $MSE=20.75$, $p<0.10$, $\eta^2= 0.03$.

Table 1: Study A: Mean hit rates in target and non-target items of the exam for the practiced and unpracticed participants.

	Non-target items	Target items	Difference
Practiced Group	.67 (.03)	.35 (.04)	*.32*
Unpracticed group	.56 (.03)	.11 (.04)	*.45*
Difference	*.11*	*.24*	

The corresponding mean standard errors can be seen within parentheses

Hit rates as ratios of number of hits per number of items have the advantage of giving us a close enough view of the participants' performance levels. However, one problem with this measure is that it does not control for guessing. To avoid these spurious effects, we assigned a cost to every error. As it is usually done for 3-choice tests, we computed for each participant and each kind of items, a corrected performance estimate with a penalty of half a hit per commission error. Also, since the number of items varies across item conditions, the cost and benefits per item were adjusted so that the estimates of both target and non-target items were on the same scale. Table 2 shows the mean net values for the four experimental conditions of our design on a scale of 10 points. As can be seen, there were clear effects of both the group factor ($F(1,62) = 23.59$, $MSE=2.63$, $p<0.05$, $\eta^2= 0.14$) and the item factor ($F(1,62) = 77.66$, $MSE=0.80$, $p<0.05$, $\eta^2= 0.40$). Certainly, participants were much better at the TOT-unrelated items than at the target ones. And practiced participants achieved overall higher records on the qualification exam. But, once again contrary to our expectations, the groups were similarly less efficient as for the target items, as shown by a decrease of 3.6 and 3.7 points for the practiced and unpracticed groups, respectively ($F<1$, for the interaction between the practice and item-type factors).

Table 2: Study A: Mean net values in target and non-target items of the exam for the practiced and unpracticed participants

	Non-target items	Target items	Difference
Practiced Group	6.05 (.29)	2.44 (.47)	*3.61*
Unpracticed group	4.23 (.43)	.53 (.39)	*3.70*
Difference	1.81	1.91	

The corresponding mean standard errors can be seen within parentheses.

Study B

Following our university official examination schedule, two weeks after the exam session of the study A, a new exam session took place. Only students that had not applied for the first session could apply for the second one. As is usually the case at our university, most of the students in the course assisted to this second session, once they knew the general features of the exam from the first session. Throughout this time, the opportunity to work with the TOT Java application was open. As a consequence, students applying for the second exam session had more time to interact with the TOT procedure than their fellows of the first session. Additionally, our university facilities, once an exam has been celebrated, provide the exam content on the Internet for download, in order for the students to get familiar with it. So, our second-exam applicants knew about the relevance of the TOT-practice in the first exam, although they had no way to guess if it would the same for the second session.

In this study, the same type of analyzes as those described for the Study A were performed. Due to the few reasons mentioned above, the data are not strictly comparable, so that an analysis on the whole set of pooled data seems inappropriate. This study followed the same procedure as Study A, with the exception of the participants that took part in it, which were different.

Method

Participants

The data for this study were taken from the 234 students who took part at the second examination session of the *Basic Psychology* course. They were 189 women and 45 men, aged between 18 and 61 years (Mean= 33, *SD*=9.3). Of these students, 119 voluntarily applied for the participation in at least one web session of the available TOT procedure.

Materials

An independent set of 30 new, 3-alternative items were the content of the qualification test for the second session. As described before, the assignment of this exam to the second session was randomly performed two months before the first exam session. No item was discarded from this exam, as no composition error was detected. Consequently, in this study, the test includes 24 non-target items and 6 target-items.

All other features of the used materials and procedure are the same as those described for Study A.

Results

The same analyses as in Study A were run on the data of the second-session exam. Table 3 shows the mean hit rates for the two types of items and for both the practiced and the unpracticed groups of Study B. Clearly, hit rates seemed to be overall close to 50 percent, with the exception of participants unpracticed on TOT-related items, whose performance noticeably decreased. This pattern was confirmed by a significant group by item-type interaction, $F(1, 232) = 71.62$, MSE=3.24, $p<0.05$, $\eta^2 = 0.13$. Also, there was a significant effect of group $F(1, 232) = 107.70$, $MSE=2.15$, $p<0.05$, $\eta^2 = 0.19$, and item-type $F(1, 232) = 70.63$, $MSE=3.28$, $p<0.05$, $\eta^2 = 0.13$, although the relevance of these effects is clearly limited by the pattern of the significant interaction.

Table 3: Study B: Mean hit rates in target and non-target items of the exam for the practiced and unpracticed participants

	Non-target items	Target items	Difference
Practiced Group	.49 (.01)	.50 (.03)	*-.01*
Unpracticed group	.46 (.01)	.16 (.02)	*.30*
Difference	*.03*	*.34*	

The corresponding mean standard errors can be seen within parentheses.

A fairly parallel pattern of results can be seen in Table 4. The interaction was also significant for the net value means $F(1, 232) = 37.72$, $MSE=6.15$, $p<0.05$, $\eta^2 = 0.07$, as well as the main effects ($F(1, 232) = 84.37$, $MSE=2.75$, $p<0.05$, $\eta^2 = 0.17$, for the group, and $F(1, 232) = 32.58$, $MSE=7.12$, $p<0.05$, $\eta^2 = 0.06$, for the item-type factor).

Table 4:- Study B: Mean net values in target and non-target items of the exam for the practiced and unpracticed participants.

	Non-target items	Target items	Difference
Practiced Group	3.83 (.17)	3.91 (.28)	*-.08*
Unpracticed group	2.99 (.20)	.70 (.15)	*2.29*
Difference	*.84*	*3.21*	

The corresponding mean standard errors can be seen within parentheses.

Overall, the data of this Study B support the idea that items regarding the TOT procedure were relatively more difficult for our students. Nevertheless, not surprisingly, those engaged in the TOT-practice were able to normalize their performance on these items up to their achievement at the control items.

Discussion

Before drawing conclusions from our research, it should be acknowledged that our experimental procedure does not perfectly fit the purest definition of an experimental design, mainly due to our participants not having been randomly assigned to the experimental conditions (Campbell & Stanley, 1966). Yet, the contrast between target and non-target items for both practiced and unpracticed participants seems to give us reasons to confidently draw some conclusions: the within-session patterns of both, session A and B taken together, amount to the effectiveness of practicing with the TOT application through the internet. Notice that our conclusion gains generalizability from the fact that the studies were run along the ordinary course-term development in our distance education university.

From the American Psychological Association, Steven Beckler (2014a, 2014b) has emphasized that most of the contents typically dealt with in an undergraduate Psychology course are included in the category code 42.2799 within the *Classification of Instructional Programs* (CIP) system used by the U.S.A. *Nation Center for Education Statistics* (NCES). The interesting issue here is that this CIP code is usually included by some leading institutions in the STEM (Science, Technology, Engineering, and Mathematics) group. Indeed, as it is the case for most of the STEM disciplines, Psychology courses for distance education have to cope with the specific difficulties produced by the lack of a direct access to lab facilities by the students. Our research was aimed at showing how some of the shortcomings for Psychology as a STEM discipline in a distance education institution could be overcome. Thus, our data add to those showing that for Psychology to be considered as a STEM discipline, the use of computers as lab analogues can be very profitable to spread among students "the critical idea that human thought and behavior can be studied scientifically" (Breckler, 2014b, p. 48; see also Gurung et al., 2016).

The present research shows that it is possible to modernize the traditional models of psychology teaching, applying information technology (IT) in the psychological science learning and instruction. Specifically, our data supports that a digitized version of the laboratory procedure developed to study a seemingly ordinary psychological phenomenon could be a powerful tool for psychology undergraduates. Indeed, this research is in line with those studies showing how the scientific education can be improved by the use of IT tools aimed to foster specific scientific cognitive skills, such as analysis and evaluation of phenomena in nature (Kirschner & Huisman, 1998). Research on the use of ITs in the learning and instruction of, for example, biology (e.g., Sewell, Stevens & Lewis, 1995), physics (Quellmalz, Timms, Silbergitt & Buckley, 2012), medicine (e.g., Bonnetain, Boucheix, Hamet & Freysz, 2010), can be found in the literature.

However, to our knowledge, there is no research dealing with the advantages of the IT use for the learning and instruction of procedures in experimental psychology. Also, it should be stressed here that our knowledge domain, being ordinary psychological phenomena and experiences, deserves a special consideration, as it usually offers a certain difficulty to be viewed from a scientific stance by the non-initiated student. Our main conclusion would be that, with the use of digitized analogues of well-known psychological research procedures, such difficulty could be overcome.

The efficiency of IT products as learning tools for psychology seems to be specially suited for distance education systems (although for some cautions see Clay, 2014). Our work clearly shows that these technologies should be massively implemented as a supplement to text material for improving the contact between psychology students and their course contents (Bernard et al., 2009). Thus, the psychological phenomena comprehension from a scientific view point could achieve the conceptual richness and complexity that could only be attained with active and interactive study (i.e. Sitzmann, 2011). Additionally, the instructor and evaluator could gain a much sophisticated assessment tool to evaluate the knowledge of psychological concepts and the competence on psychological procedures

(Pellegrino, Chudowsky & Glaser, 2001). Certainly, the way that students interact with the digitized materials could be traced in order for the instructor to assess the learning progress or the especially difficult steps.

Finally, it should also be noted that the implementation of digitized laboratory analogues of scientific psychological procedures could make the consideration of psychology as a scientific discipline a widespread view among non-psychologists as well. As it has been acknowledged by the American Psychological Association "APA is working to resolve one of psychology's great public relations problems: the fact that other scientists, lawmakers and the general public don't always view psychology as one of the STEM —science, technology, engineering and math— disciplines" (Price, 2010, p. 32). We think that in order to deal with this problem, psychologists and psychological institutions could do a great job entering IT versions of laboratory psychological procedures within the growing Massive Open Online Courses (MOOCs) as well as in other distance education programs.

Conclusions

The present research shows it is profitable to apply information technology (IT) in the psychological science learning and instruction implemented by a distance education institution. Specifically, our data supports that a digitized version of the laboratory procedure developed to study a seemingly ordinary psychological phenomenon could be a powerful instrument for psychology undergraduates. This strategy could help to cope with the specific difficulty associated to ordinary behavioral experience (explained by *folk psychology* as something being on the tip of the tongue) to be viewed from a more-educated scientific stance (*scientific psychology*). With the use of digitized analogues of psychological research procedures, such difficulty could be overcome in the context of distance education institutions or MOOC courses.

Conflict of Interest

The authors declare that they have no conflict of interest.

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