ReCALL **19**(1): 21-38 2007 © European Association for Computer Assisted Language Learning
DOI: 10.1017/S0958344007000316 Printed in the United Kingdom

Learners' strategies with a grammar application: the influence of language ability and personality preferences

FENFANG HWU
Department of Romance Languages and Literatures, University of Cincinnati, OH, USA
(*email: hwuf@ucmail.uc.edu*)

Abstract

This case study investigated the ways pre-major and pre-minor students of Spanish interacted with a grammar application from four perspectives. Firstly, using the computer's tracking ability to collect learners' behaviors, the study set out to uncover the different ways learners approached the application. Secondly, the study assessed the influence of two learner variables on learning behaviors: language abilities determined by a placement test and personality preferences measured by Jung-Myers-Briggs-Typology based approach. Thirdly, the study assessed whether the frequency of various behaviors resulted in different knowledge increases. Finally, the study categorized the uncovered behaviors into the learning strategies covered in the Strategy Inventory for Language Learning (SILL) (Oxford 1990). The study concludes with implications for software improvement, as well as with indications of likely directions for future research.

Keywords: grammar instruction, individual difference, learning strategy, MBTI, personality preference

1 Introduction

Computer-assisted language learning (CALL) researchers have been using the computer's tracking ability to document learners' behaviors in their use of computer-based language learning materials since as early as the 1980s (e.g., Curtin, Avner & Provenzano, 1981; Chapelle & Mizuno, 1989). To date, learners' behaviors with a variety of CALL materials have been documented. Among the studies that document learners' behaviors, some have investigated whether students made use of the program options provided and the language learning strategies the software supported (e.g., Chapelle & Mizuno, 1989; Liou, 1997). The researchers wanted to find out whether learners actually did what the programs asked them to do and whether learners knew how to use appropriate strategies. Some studies have used the behavioral data to provide evidence to support the learning strategies reported in learning strategy research (e.g., Jamieson & Chapelle, 1987; Liou, 1997) because the learning strategies themselves

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

helped researchers better understand second language acquisition process. CALL researchers also have investigated whether different behaviors or program options yielded different learning outcomes (e.g., Chun & Plass, 1996; Collentine, 2000; Davis & Lyman-Hager, 1997). The underlying assumption is that those options that yielded better results needed to be recommended or provided to all learners.

On the other hand, studies aiming to uncover how different learning strategies or program options favor different learners or different groups of learners remain scarce. Insights on this issue can help designers adapt CALL instruction to the needs of individual learners, consequently achieving some congruity between learners' learning style or preference and the type of instruction provided. Although CALL researchers have found that students of different ability levels or styles used computer-based materials differently (e.g., Chun, 2001; Curtin *et al.*, 1981; Desmarais, Laurier & Renié, 1998; Jamieson & Chapelle, 1987), these differences have rarely been recognized as program design options. In sum, despite the potential of CALL in accommodating individual learners, the number of computer-based language instruction programs that has taken into account learners' differences remains limited (some exceptions are: Abraham, 1985; Grace, 1998; Meredith, 1978). In a survey about unanswered questions in CALL (see Hubbard, 2002), a number of researchers pointed out the need for CALL designers to consider learner differences. The question however remains about what learners' differences need to be taken into account in what types of programs.

The objective of the current study is to investigate how differently students used a grammar application, whether two learner variables affected their learning behaviors, whether the different behaviors resulted in different knowledge increases, and to what learning strategies reported in the Strategy Inventory for Language Learning (SILL) (Oxford, 1990) the uncovered behaviors correspond. The ultimate goal is to utilize the insights gained to create individualized instruction. The study began by verifying whether the application contributed to the students' learning through comparing the knowledge gains between the experimental and the no-treatment groups. Since learners' behaviors are partly determined by program types (e.g., dictation, spelling, or reading) and the program type of the current application was unique (it taught pragmatic meanings), the study took an exploratory approach regarding what learning behaviors would be discovered. Two learner variables though were hypothesized to influence learning behaviors. Language ability as measured by a placement test was selected because it was often recognized as a variable that could affect language learning behaviors. Personality preferences as measured by Jung-Myers-Briggs typological approach were considered because it had been used in a variety of educational settings and its applications in those settings had been widely investigated and shown great insight and promise in assisting educators in understanding learner differences (see Lawrence, 1979/1995, 1984; Myers, McCaulley, Quenk & Hammer, 1998/2003). Additionally, researchers in second language acquisition (e.g., Carrell & Monroe, 1993; Ehrman & Oxford, 1989, 1990; Moody, 1988) and computer-assisted language learning (e.g., Beauvois & Eledge, 1995/1996; Grace, 1998; Meunier, 1996) had used it previously as an adequate, reliable, and valid instrument.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

2 Personality preferences

In this section, we will review the theory that underlies the personality instrument Jung-Myers-Briggs typology and some of its applications in second language learning.

2.1 Theoretical basis

The Jung-Myers-Briggs typology is based on the theory of psychological types described by Carl Jung (1971), which was later expanded by Isabel Briggs-Myers. Jung's theory claims that "much seemingly random variation in behavior is actually quite orderly and consistent, being due to the basic differences in the way individuals prefer to use their perception and judgment" (Myers *et al.*, 1998/2003: 3). Perception involves "all the ways of becoming aware of things, people, happenings, or ideas" and

Table 1. *Descriptions of the four sets of opposite preferences*

1	Extraversion	Directing energy mainly toward the outer world of people and objects.
	Introversion	Directing energy mainly toward the inner world of experiences and ideas.
2	Sensing	Focusing mainly on what can be perceived by the five senses.
	Intuition	Focusing mainly on perceiving patterns and interrelationships
3	Thinking	Basing conclusions on logical analysis with a focus on objectivity and detachment.
	Feeling	Basing conclusions on personal or social values with a focus on understanding and harmony.
4	Judging	Preferring the decisiveness and closure that result from dealing with the outer world using one of the Judging processes (Thinking or Feeling).
	Perceiving	Preferring the flexibility and spontaneity that results from dealing with the outer world using one of the Perceiving processes (Sensing or Intuition).

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

judgment involves "all the ways of coming to conclusions about what has been perceived" (Myers *et al*., 1998/2003: 3). The theory postulates that "if people differ systematically in what they perceive and in how they reach conclusions, then it is only reasonable for them to differ correspondingly in their interests, reactions, values, motivations, and skills" (Myers *et al*., 1998/2003: 3).

The instrument is a forced-choice self-report questionnaire and classifies individuals according to four sets of dichotomies or opposite preferences: (1) extraversion vs. introversion; (2) sensing vs. intuition; (3) thinking vs. feeling; and (4) judging vs. perceiving. It assumes that every person uses both poles of each of the four dichotomies at some time but responds first and most often in a preferred style. The four dichotomies combine to yield distinct individuals into 16 types. Table 1 provides a description of each preference, taken from Myers *et al*. (1998/2003: 6).

2.2 Applications of personality preferences in second language learning

Various studies have examined the relevance of the personality preferences to second language learning. In what follows we will look at some applications relating to the study. Using self-reported surveys to elicit learning strategies, Ehrman and Oxford (1989: 9) found "statistically significant connection between intuition and strategies for searching for and communicating meaning, affective strategies, authentic language use, and formal model building". They explained that this connection of intuition with techniques that "build on drawing inferences (searching for and communicating meaning, formal model building), seeing the whole (formal model building […]), and working with patterns (searching for and communicating meaning, formal model building, affective strategies) fits with such features of intuition", which include "interest in the whole, preference for the abstract, global thinking, and alertness to patterns rather than details".

In a different report, the same researchers (Ehrman & Oxford, 1990: 319–320) indicated that most of the Intuitives "typically used global processing and imposed their own structure and learning design". "Intuitives conceptualized, desired complexity, and searched for the "big picture." Many Intuitives said they "relied heavily on guessing from context, did not need complete comprehension, and were comfortable with linguistic risks and experimentation". Sensing students, on the other hand, showed "the strongest appreciation of memory strategies". It was "*only* Sensing students who said that they actually liked to memorize". Their memory strategies were "concrete and often multisensory including imagery (realia, drawings, schematics, but with little mention of purely mental imagery), physical response strategies, mechanical tricks (color-coding, flash cards), structured reviewing, and just plain rote memorization". Sensing people "consistently preferred carefully sequenced, small, digestible portions" and some said they liked this to be done for them. The researchers also commented that "[w]eaker students who prefer sensing are likely to get into trouble when they are required […] to make inferences, especially guessing from context" (Ehrman & Oxford, 1989: 9).

The above findings are consistent with a number of reports. They are consistent with the research findings summarized in the *MBTI manual* (Myers *et al*., 1998/2003: 263). Sensing types have been found to like sequential learning and in general favor both collaborative and dependent learning styles. Their approach to creativity tends to be adaptive, while Intuitive types are innovative, on the *Kirton Adaption and Innovation*

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Inventory.[1] "Sensing types approach learning through fact retention, methodical study, and serialist learning" and were reported as "valuing concrete experience on *Kolb's Learning Style Inventory*, while Intuitive types instead valued abstract conceptualization".

Further, those findings are consistent with the research findings of learning preferences associated with the criterion of Sensing/Intuition, summarized in Lawrence (1979/1995: 40-41) (see Table 2).

Finally, those findings are consistent with the predictions of Jung's theory. Type theory suggests that "Sensing types can and will produce original ideas but usually after first consulting what they know for sure about a topic". "They carefully (and more slowly than do Intuitive students) follow each step in sequence. Thus grounded in the real data, they can then produce the kind of big picture that does not lack in detail (as so many of the initial dreams of Intuitive types do)." Conversely, "Intuitive types can best learn to accumulate necessary facts if their imaginations are first allowed to roam free, without impediment or excessive rules. Once inspired, Intuitive types then have psychological energy left to fill in the missing pieces" (Myers *et al*., 1998/2003: 263).

3 Method

3.1 Participants

The 34 subjects were the entire student population enrolled in the fifth-semester Spanish

Table 2. *Learning preferences associated with the dimension of Sensing/Intuition*

Sensing	**Intuition**
Tasks that call for carefulness, thoroughness, and soundness of understanding	Tasks that call for quickness of insight and in seeing relationships
Going step-by-step	Finding own way in new material
Tasks that call for observing specifics	Tasks that call for grasping general concepts
Tasks that call for memory (recall) of facts	Tasks that call for imagination
Practical interests (independent of intelligence)	Intellectual interests

1. The Adaption-Innovation Theory provides insight into how people solve problems. Those scoring as more adaptive (the terms adaptive and innovative are relative), as measured by the *Kirton Adaption Innovation Inventory* (KAI), approach problems within the given terms of reference, theories, policies, precedents and paradigms and strive to provide 'better' solutions (e.g. continuous process improvement). By contrast those more innovative tend to detach the problem from the way it is customarily perceived and, working from there, are liable to produce less expected solutions that are seen as being "different" (e.g. reengineering).

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

courses, the first required course for Spanish majors and minors, at a mid-size university in a mid-west city in the US. Their ages were between 18 and 22. This group of students was selected because students at this level continue to struggle with the grammar point to be covered in the experiment while they are ready to learn the grammar point with the degree of understanding that the computer application aims to provide. The students enrolled in one of the two classes were assigned to the experimental group (N=18). They thus used the computer application during the experiment. Those enrolled in the other class did not receive the treatment (N=16). In other words, they did not use the application.

3.2 Materials

3.2.1 The computer application

The computer application was created by the author. The objective was to teach the uses of two Spanish past tense forms (preterite and imperfect). Spanish soap opera clips were used to demonstrate various pragmatic meanings of the verb *(no) querer* 'to (not) want' in conversations. These clips allowed students to view the language input in its full discourse context including body language. By referring to pragmatic meanings and the conversation principles that speakers subconsciously follow to ensure communication (Grice, 1975), the application also explained why one of two verb forms was suitable or not suitable for a context (see Hwu, 2005).

The application had 19 lessons. Although the pages/activities in the application followed a linear order, students could navigate to any page at any point in the application (see Figure 1). Before the lessons began, an introduction page explained the purpose of each activity in a lesson. Another page explained the general functions of preterite and imperfect (e.g., preterite makes the endpoint of an event visible for pragmatic interpretation while imperfect does not). At the end of the 19 lessons, a page

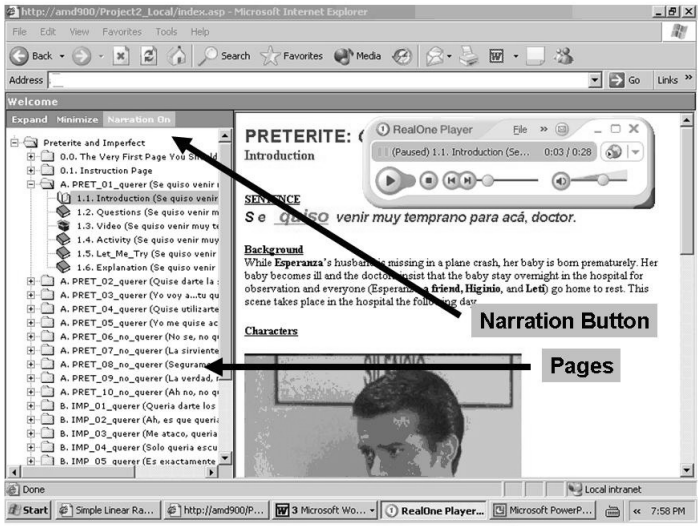


Fig. 1. A Snapshot of the Application Interface.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

summarized the various uses of the verb included in the application and a page tested the student's knowledge on these lessons with multiple-choice questions. All the instructions and explanations in the application were in the students' native language, English.

Each of the 19 lessons consisted of six activities/pages: (1) The Introduction page provided background information about the story in the video and introduced characters in the story through the snapshots of the video; (2) The Preview-Questions page asked students to preview questions designed to draw their attention to key information in the video; (3) The Video page asked students to view a short clip in the target language, which was accompanied by captions and glosses; (4) The Activity page asked students to respond to the questions that they had previously read on the Preview-Questions page; these questions were self-corrected; (5) The Let-Me-Try-To-Explain-It page asked students to come up with their own explanations about the use of the target verb encountered in the video; and (6) The Explanation page provided detailed explanation about the use of the target verb encountered in the video. Four major explanations were provided: (1) the speaker's intention: drawing on the storyline, what the speaker, who uses the target verb form, intends to convey; (2) what reference point is used by the speaker to confine an event if the preterite is the verb form used; (3) whether the other verb form is acceptable in the story; if it is not acceptable, how the other verb form changes the story; (4) explanations of the use of the target verb form from the perspective of pragmatics (e.g., the speaker did not want to do it originally but did it anyway). To facilitate students who might prefer to have the English instructions and explanations read aloud to them, a narration button on the application allowed the learners to turn narrations on and off at any time.

A computer programmer created the tracking system, in which the application was delivered by Microsoft IIS server (Internet Information Service). ASP was used to create web pages dynamically, resulting in a tree-structured table of content appearing on the left-hand side of the screen. JavaScript was used to collect the student's actions on the pages (e.g., the pages clicked, the time when a page was clicked, the answers submitted). These data were sent to the server and recorded to database.

3.2.2 Placement Test, Personality Instrument, and Post-Experiment Survey

Wisconsin Spanish Placement Test was chosen as the measure of Spanish ability. The test consisted of a grammar test and a reading test, all of which were multiple choices. A Jung-Myers-Briggs typology based questionnaire, which consisted of 72 questions[2], was used to measure personality preferences. A post-experiment survey was used to elicit students' retrospective accounts of their learning experience with the application.

3.3 Procedure

A between- and within-subject design was used to examine the effect of the application. The activities related to the experiment were integrated into the course syllabi of both the experimental and the no-treatment groups. The study was explained to both groups

2. See the questionnaire on http://www.humanmetrics.com.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

of students verbally and in writing. They were informed that whether they chose to have their data included in the experiment would not have any bearing on their course grades although they would all participate in the activities related to the experiment because they were an integral part of the course. Both groups of students understood that they would be given a pre-test and a post-test and that the researcher would go over the test with them after the experiment. The experimental group was informed that their scores of Wisconsin Spanish Placement Test, taken as part of the requirement of the Spanish program, at the beginning of the semester, would be used for the study. They also understood that they would be given a personality questionnaire and a post-experiment survey and their use of the preterite and imperfect lessons would be observed, but not what type of data would be collected. To help maintain the motivation of the no-treatment group and provide them with the same learning opportunity as the experimental group, they were informed that they would be given access to the application after the experiment. Both groups were told that as a token of appreciation of their participation in the experiment, the researcher would be willing to assist in their learning of Spanish throughout their study in the university. All students voluntarily chose to have their data included in the experiment and signed the consent form.

Excluding the introduction and the orientation of program features, approximately 225 minutes of regular class sessions were used for the experiment, which took place in a computer lab about one month after the semester started. Some students finished the application early and left the lab before the last lab session ended. Since the application was accessible to the students through the Intranet, students who missed one or two lab sessions finished the work outside of classes. The researcher was present during the entire lab sessions observing students' behaviors and did not notice any deficiency in the students' computer skills relevant for the experiment. Additionally, the students had regularly used a multimedia program accompanying the textbook before the lab sessions began.

Although the pages of the application were organized in a linear way, students in the experimental group were reminded that they could use the program in the most comfortable manner for them. Their learning behaviors were recorded by computer-aided tracking. A total of 2665 records of accessed pages and 246 records of explanations for the Let-Me-Try-To-Explain-It page were collected. Students answered the web-based personality questionnaire and the post-experiment survey approximately one week after the lab sessions.

The no-treatment group did regular classroom activities during the same period when the experimental group did the lab sessions. They learned preterite and imperfect following the rules and activities included in the textbook[3], which did not address the uses of preterite and imperfect in conversations and provided explanations of the uses of past tenses largely different from the computer application.

A pre-test and a post-test were given to both groups of students one week before and after the lab/classroom sessions respectively. The pre-test and post-test contained the same thirteen questions, which included thirteen stories in English. The same questions

3. *Punto y aparte* published by McGraw Hill was the textbook used for both classes during regular class sessions.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

were used in order to determine whether the students' understanding had improved from pre-test to post-test. Students had to choose the appropriate response: preterite, or imperfect, or both, as part of a dialogue in Spanish according to the English plot (see Appendix A for an example). Given the nature of this grammar point, the chance of guessing the right answer is between 50% and 100%.[4] Consequently, students were required and reminded to provide reasons for their choice/s. Full credits were given when the answers were correct and the accompanying reasons were correct and complete. Partial credits were given when the answers were correct but the reasons were incomplete. If the reason was not provided or incorrect, even if the answer was correct, zero score was assigned. If the answer was incorrect, zero score was assigned. Since 4 out of the 13 stories accepted both verb forms as correct answers, the maximum score possible was 17, rather than 13.

4 Results

4.1 Effect of the application

Table 3 illustrates the results of mean test scores and standard deviations for the experimental and no-treatment groups. It shows that the mean pre-test scores of both groups are about the same and the mean score of the experimental group improved from pre-test to post-test while the mean score of the no-treatment group remains more or less the same.

To determine the possible effect of the application on the learning of Spanish preterite and imperfect, raw scores of pre-tests and post-tests of both groups were tabulated and repeated-measures analysis of variance (ANOVA) was performed. Group (experimental, no-treatment) was the between-subjects factor and Time (pre-test, post-test) was the within-subjects factor. The results shown in Table 4 reveal a substantial interaction between Group and Time. In other words, Time has a substantial effect on the post-test for the experimental group, but not for the no-treatment group. The effect size using Cohen's formula[5] is 1.62.

The significant knowledge increase of the experimental group indicated that the application could be used to help improve students at this level in their understanding of the uses of Spanish preterite and imperfect in conversations. Although the current application only addresses one verb, it is likely that the knowledge gained on this verb can be extended to the uses of other verbs that share similar semantic or pragmatic distributions.

---

4. Although in many contexts both verb forms are acceptable, textbooks and grammar reference books have always presented this grammar point as there is only one form acceptable for a context.
5. Cohen's effect size formula used in the study:
   Cohen's $d = M_1 - M_2 / \sigma$pooled
   where σpooled = $\sqrt{[(\sigma 1^2 + \sigma 2^2) / 2]}$
   M1 = mean of the post-test of the experimental group
   M2= mean of the post-test of the control group
   σ1= standard deviation of the experimental group in the post-test
   σ2= standard deviation of the control group in the post-test

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Table 3. *Descriptive statistics of test scores of experimental and no-treatment groups*

Test	Group	N	Mean	Std Dev	Minimum	Maximum	Range
Pre-test	No-treat	16	2.33	2.20	0.25	8.50	8.25
Pre-test	Exp.	18	1.93	1.51	.00	6.00	6.00
Post-test	No-treat	16	2.25	2.21	.00	7.50	7.50
Post-test	Exp.	18	7.24	3.76	2.50	12.75	10.25

Table 4. *Summary table for repeated measures analysis of variance*

Source	*df*	*SS*	*MS*	*f*	*p*
Between-subjects Effects GROUP	1	89.17	89.17	8.45	.0066
Error (Group)	32	337.54	10.55		
Within-subjects Effects TIME	1	115.73	115.73	42.78	<.0001
GROUP x TIME	1	122.76	122.76	45.37	<.0001****
Error (TIME)	32	86.58	2.71		

*p**** < .0001*

4.2 Learning behaviors observed through log files

Two main behaviors were derived from the log files. The first behavior consists of coming up with original explanations about the use of a verb before reading the Explanation page. The log files reveal that students read the Explanation page *after* doing the Let-me-try-to-explain-it page activity (see Table 5). The second type of behavior consists of *not* coming up with original explanations about the use of a verb. The log files in such a case reveal the following patterns: (1) reading the Explanation page *before* doing the Let-me-try-to-explain-it page activity; (2) reading the Explanation page first *without* ever going back to do the Let-me-try-to-explain-it page activity; (3) *clicking* through the Let-me-try-to-explain-it pages. Sequences showing the variability

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Table 5. *Various sequences revealed by the log files*

Sequences revealing that students came up with original explanations	*Sequences revealing that students did not come up with original explanations*
1, 2, 3, 4, **5, 6** 1, 2, 3, 4, 3, **5, 6** 1, 2, 3, 3, 3, 3, 3, 3, 4, **5, 6*** (*the page 3s above are Video pages from different lessons)	1, 2, 3, 4, **6** 1, 2, 3, 4, **6, 5** 1, 2, 3, 4, **5, 6*** (*spent less than 5 seconds on page 5) 1, 2, 3, 4, **6, 5, 6** 1, 2, 3, 4, **5, 6, 5** 1, 2, 3, 4, **5, 6, 5, 6** 1, 2, 3, 4, **5, 6, 5, 6, 5** 1, 2, 3, 4, **5, 6, 5, 6, 5, 6**

of the second type of behaviors, Type II behavior henceforth, are shown in Table 5. For instance, the log files reveal the following sequence: 1, 2, 3, 4, 6, 5, 6, which indicates that the student read the Explanation page (page 6) before writing explanations about the use of the verb form (page 5). Then, he/she read the Explanation page (page 6) again before moving on to the next lesson.

When the students came up with original explanations about the use of a verb, it indicates that they probably used a cognitive strategy (see Oxford, 1990: 286). In other words, the students developed their own understanding of how the language worked, even if sometimes they had to revise their understanding based on new information, namely, the information provided on the Explanation page.

When the students skipped or clicked through the Let-me-try-to-explain-it pages, it indicates that the students probably used either a memory strategy to remember the information on the Explanation pages or a cognitive strategy to try to reason the explanations *deductively* (see Oxford, 1990: 19). When the students read the Explanation pages *before* doing the Let-me-try-to-explain-it page activities, it indicates that the students probably used a cognitive strategy to help them learn, that is, they made summaries of new language material (see Oxford, 1990: 285) although not with the intention of "creating structure for input and output" (Oxford, 1990: 19). On the other hand, it is possible that making summaries of Explanation pages was used as a memory strategy to help recall the information on the Explanation pages.

Table 6. *Pearson correlations between Type II behavior and placement scores (*p<.05)*

	Grammar	Reading	Total Scores
Type II	0.08	–0.48*	–0.27

*(*p<.05)*

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Table 7. *The number of students in each personality preference*

Preference	E	I	N	S	F	T	J	P
Number	12	6	9	9	12	6	10	8

Note: E = Extroversion; I = Introversion; N = Intuition; S = Sensing; F = Feeling; T = Thinking; J = Judging; P = Perceiving

4.3 Relationships between Type II behavior and students' placement test scores

The number of times that each learner had the Type II behavior was tallied. Pearson Correlation was performed to determine if there was a relationship between the frequency of Type II behavior and the placement test scores. The results (see Table 6) showed that no significant correlation was found between the frequency of Type II behavior and the grammar scores or between the frequency of Type II behavior and the total placement scores. However, a slightly negative correlation was found between the frequency of Type II behavior and the reading scores. In other words, students with lower reading proficiency tended to have more Type II behavior.

It seems logical that students with lower placement scores, for example in reading, would not feel comfortable with coming up with original explanations about a language use.

It is however surprising to see that grammar placement scores were not related to Type II behavior. Perhaps this is due to the fact that the grammar placement exam tests discrete knowledge about the language rather than global understanding of the written language, as the reading placement exam does; the ability to understand and analyze the spoken language (which in addition to its aural format was presented in written format through captions) is probably more related to the ability to understand the written language (the reading placement exam).

4.4 Relationships between Type II behavior and personality preferences

Since the two preferences of each personality dimension are polar opposites (Introvert vs. Extrovert, Intuition vs. Sensing, Feeling vs. Thinking, Judging vs. Perceiving), a negative or a positive value was assigned to the clarity of preference in each case. For instance, with regard to the dimension N/S, a student of Intuition, with the clearness of

Table 8. *Pearson correlations between personality dimensions and Type II behavior*

	E/I	N/S	F/T	J/P
Type II	0.01	0.59**	0.07	17

*Note: E/I = Extroversion/Introversion; N/S = Intuition/Sensing; F/T = Feeling/Thinking; J/P = Judging/Perceiving; Type II = Type II behavior. **p < .01*

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

preference of 11%, is assigned the value of -11 while a student with the opposite preference (Sensing), with the clearness of preference of 33%, is assigned the value of 33. The values of each dimension of personality were compared with the numbers of Type II behavior to determine if there was a relationship. Table 7 shows the numbers of students with each personality preference.

Table 8 shows that no statistically significant correlations were found between Type II behavior and the following personality dimensions: E/I, F/T, J/P. Nevertheless, a significant positive correlation between Type II behavior and the personality dimension N/S was found. In other words, as the value of N/S (Sensing preference) increases, the value of Type II behavior increases.

4.4.1 Comparing the frequency of Type II behavior between Sensing and Intuitive students

To further verify the significant relationship between Type II behavior and Sensing preference, a nonparametric test, Wilcoxon, was used to compare the frequency of Type II behavior between Sensing and Intuitive students. This test was selected because it does not require the assumption of normal distribution in each of the two groups. The result showed that the Sensing students' Type II behavior was significantly higher than the Intuitive students' Type II behavior (*p = .03).

The fact that Sensing students had more Type II behavior implies that they tended to not feel comfortable with coming up with original explanations about a language use in this environment. The log files showed that they coped with the situation by either reading the grammar explanations first or avoiding the activities that asked them to come up with grammar explanations. Intuitive students on the other hand tended to stick with the program design as they tried to come up with some explanations about the language use. This does not necessarily mean that they felt confident about the task. But rather the task was not so unpleasant that they had to look for ways to make it more enjoyable.

These results fit with the Sensing_Intuition dichotomy predicted by Jung's theory as well as the research findings related to Sensing_Intuition contrast discussed earlier in the article. Namely, Sensing students' approach to creativity tends to be adaptive while Intuitive types are innovative. Sensing types approach learning through fact retention, methodical study, and serialist learning. They can and will produce original ideas but generally after first consulting what they know for sure about a topic. Intuitive types can best learn to accumulate necessary facts if their imaginations are first allowed to roam free. When inspired, they then have psychological energy left to fill in the missing pieces.

Students' post-experiment survey comments (see Tables 9 and 10) seem to concur with the above observations. Intuitive students tended to focus more on their ideas and thoughts. When they read Explanation pages, they were to verify their ideas. In other words, they developed their own understanding of how the language worked even if later they had to revise their understanding based on new information. Conversely, Sensing students focused more on how well the Explanation page explained the grammar point and how it helped them understand. Additionally, they expressed not wanting to get off track, wanting to recall information, taking information piece by piece, and disliking guessing. They were to receive information rather than confirming their ideas when they read Explanation pages.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Table 9. *Comments of strategies from intuitive students*

1.	It [the sequence of the activities] seems logical. I liked having the explanation at the end after I had time to think through it.
2.	What I preferred to do was listen to the video one time through. Then I would replay, pausing it to read the script when I could not understand it. After that I would listen to the whole video again all the way through to have my listening skills and finally to get a feel for why the preterite or imperfect was used and why it made sense in its context. I would re-watch the videos until I felt I knew why the tense was chosen that was used… I preferred the explanations to shed light on the accuracy of my ideas. I compared it to my explanations and used it as a foundation for further learning. I wanted to ensure I understood it both accurately and completely. Often, I found my explanations were accurate but incomplete– That is the tense used conveyed more than I realized.
3.	To listen & read the text of the video & to then think about whether the desire was confined in the past & why/why not.
4.	I made sure I had an idea of what I thought- Then I made sure it was right. Having me try to explain it helped me think and put it into my own thoughts.
5.	I really wanted to know if I was right, not anyone else. If I get it right, then I understand… I wanted to see if I was right. If not, I went back.

Table 10. *Comments of strategies from sensing students*

1.	I followed the order of the sequence so that I would not get off track and understand what was going on. I tried to remember what all the different forms of the verb meant and the way they were used.
2.	I followed the order because it was there for a reason. [My strategies were] Reading + re-reading things that were difficult. There was a lot of information here, but I had to take it piece by piece.
3.	I read the pages where they explained the info but skipped the pages where you had to try to do it yourself. I liked the pages that explained the soap operas & why they used a certain verb tense. I like reading that first rather than trying to guess.
4.	This page [Explanation] really helped me understand.
5.	The page [Explanation] was great in explaining why the answers were what they were.
6.	I had to do each of them in class and then go home and do them over in order to eventually pick up on the explanations.
7.	There were some pages that I could not finish without a little help. [So I copied from a classmate.]
8.	I printed it [Summarizing Explanation Page] out and read it a few times.

4.5 Relationship between knowledge gain and Type II behavior

Pearson Correlation was performed to find out if Type II behavior affects students' knowledge gain. No statistically significant correlation was found between knowledge gain and Type II behavior (correlation coefficient = -.24, p = .34).

4.5.1 Comparing Sensings' knowledge gain with Intuitives' knowledge gain

Two more tests were performed to investigate the effect of Type II behavior on knowledge gain. First, the means of the knowledge gain of Intuitives and Sensings were compared. An analysis of variance where the dependent variable is knowledge gain and the independent

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

variable is personality with two levels (Intuition and Sensing) was performed. Although the mean knowledge gain of Intuitive students is higher than that of the Sensing students, there is no statistically significant difference between them (see Table 11).

Second, an analysis of covariance where the dependent variable is knowledge gain, the independent variable is personality with two levels (Sensing and Intuitive), and the covariate is Type II behavior, was performed. In other words, the mean knowledge score for each group of students (Sensing and Intuitive) was adjusted for the value of Type II behavior, the covariate. Even though the adjusted mean for Intuitive students is larger than the adjusted mean for Sensing students, there is no statistically significant difference between them (see Table 11). In sum, there is no statistically significant difference between the mean knowledge scores of the two groups of students (Sensing and Intuitive), whether adjusted for nothing or adjusted for Type II behavior.

Since the knowledge gain is not related to Type II behavior, it implies that, although students went about learning in different fashions in this CALL environment, students of differing personality preferences or reading levels could satisfy their learning preferences without negatively affecting their learning.

5 Discussion and conclusions

This research used the computer's tracking capability to record learners' behaviors with a grammar application. It sought to uncover different learning behaviors. Indeed, different behaviors were uncovered, thanks to the flexible nature of CALL applications, which allows learners to utilize the application in different ways, and the computer's capability in collecting learners' usage data unobtrusively. The discovery provides evidence that individuals can approach CALL instructions differently.

Language ability and personality were hypothesized to be related to learning behaviors. Lower reading placement scores and clearer Sensing preference were found to be connected with disliking to come up with original grammar explanations. This indicates that Sensing and Intuitive students as well as students of differing reading levels differed in the way they preferred to receive and assimilate new information in this learning context. Because different learning behaviors were not related to knowledge gains, it suggested that students who followed different paths in the application could still accomplish the learning goal. Considerations of Sensing_Intuition dichotomy and reading proficiency levels therefore probably should be integrated into the program design.

The study has inferred several learning strategies from learning behaviors. When learning new grammar concepts, Intuitive students tended to use a cognitive strategy. In

Table 11 *Comparisons of knowledge gains between Sensings and Intuitives*

	Sensing	Intuitive	p
Mean	4.31	6.31	.17
Mean Adjusted for Type II	4.44	6.17	.32

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

other words, they developed their own understanding of how the language works. Sensing students on the other hand tended to use a memory strategy to memorize grammar explanations. Or they tended to use one of the two cognitive strategies: making summaries of grammar explanations and reasoning grammar explanations deductively.

5.1 Limitations of the study and ideas for future research

A number of factors have contributed to conducting the study with a small sample size: the small number of students enrolled in this level of language classes, the unpredictable nature of students' behaviors with an uncommon application type, and the challenge of visually searching for learning patterns among a large number of usage data. More studies are certainly needed in the future to verify the findings obtained in this study. Dictated by the sample size, the study only examined the four personality dimensions rather than looking at all the sixteen personality types. To better help students' learning, it requires dealing with them as a whole person. A fairly large sample of students will be needed in future studies so that all sixteen types can be studied.

The correlation between Sensing_Intuition dichotomy and Type II behavior accounts for about 35% of all the effects on these two distributions. This means that 65% of the variance in such correlation is related to other things. The negative relationship between reading proficiency and Type II behavior accounts for about 23% of all the effects on these two distributions and 77% of the variance in such relationship is related to other factors. In short, there may be other factors related to Type II behavior and they remain to be discovered. It is likely that all these factors interact in a complex way in influencing learners' behaviors, which will need to be investigated in future studies.

The study shows that different behaviors did not significantly affect knowledge gain; future studies will need to find out to what extent students' learning will be negatively affected if they are forced to use less preferred learning strategies. On the other hand, future studies need to investigate if one learning strategy results in better retention in the long run because it encourages deeper processing. If so, instructors need to decide whether students should be encouraged to try their less preferred learning approaches, and when would be the adequate moment to do so.

5.2 Implications for software design

Although the application allows flexibility in navigation, different paths probably should be provided to accommodate individual learners. One path may be provided to facilitate Sensing students or students with lower reading placement scores, in which they will first read grammar explanations and then summarize what they have read. Their summaries or notes probably should be made available to them through the program design. Weaker Sensing students in particular probably should be guided to take this route. Since Sensing students prefer obtaining information piece by piece and memorization strategies, providing drills or exercises throughout the program will probably help them correct miscomprehensions and retain information better.

Since Intuitive students enjoy drawing answers on their own even if they have to revise or give up their original hypothesis based on the grammar explanations provided by the application, the application probably should provide problem-solving hints to guide them

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

in the right direction during their quest for patterns. The language input (the video clips) may be organized in such a way that patterns or inferences may be drawn more easily. A learning path encouraging students to go through all or some of the video clips at once may facilitate the discovery of patterns. The application may also provide opportunities for students to verify their hypotheses so that those with flaws can be detected and refined in time; since challenges may stimulate the use of imagination, some degree of challenge needs to be provided in the program to keep these students interested in the tasks.

This study has taken a first step toward individualizing a CALL application. Through documenting learners' behaviors, it has identified adequate ways to provide individualized instructions. The study has not only reflected many CALL researchers' view that documenting learners' behaviors is an essential part of CALL research (e.g. Garret, 1998) but has also discovered learning patterns that can be used to inform CALL program design. Because CALL is capable of accommodating individual learners and providing them with more efficient learning experiences, there need to be more studies that seek to uncover how different learning strategies favor different learners. More CALL applications whose program design considers individual differences are certainly needed.

Acknowledgements

The author would like to thank the programmer for the design and creation of the tracking system as well as the Center of Statistical Consulting at Bowling Green State University for assistance in statistical tests and analysis.

References

Abraham, R. G. (1985) Field independence-dependence and the teaching of grammar. *TESOL Quarterly*, **19**: 689–702.

Beauvois, M. H. and Eledge, J. (1995/1996) Personality types and megabytes: Student attitudes toward computer mediated communication (CMC) in the language classroom. *CALICO Journa*l, **13**(2 & 3): 27–45.

Carrell, P. L. and Monroe, L. B. (1993) Learning styles and composition. *The Modern Language Journal*, **77**(2): 148–162.

Chapelle, C. A. and Mizuno, S. (1989) Student's strategies with learner-controlled CALL. *CALICO Journal*, **7**(2): 25–47.

Chapelle, C. A., Jamieson, J. and Park, Y. (1996) Second language classroom research traditions: How does CALL fit? In: Pennington, M. C. (ed.), *The Power of CALL*. Houston, TX: Athelstan, 33–53.

Chun, D. (2001) L2 reading on the web: strategies for accessing information in hypermedia. *CALL Journal*, **14**(5): 367–403.

Chun, D. M. and Plass, J. L. (1996) Effects of multimedia annotations on vocabulary acquisition. *The Modern Language Journal*, **80**(2): 183–198.

Collentine, J. (2000) Insights into the Construction of Grammatical Knowledge Provided by User-behavior Tracking Technologies. *Language Learning & Technology*, **3**(2): 44-57.

Curtin, C., Avner, A. and Provenzano, N. (1981) Computer-based analysis of individual learning characteristics. *Studies in Language Learning*, **3**: 201–213.

Davis, J. N. and Lyman-Hager, M. A. (1997) Computers and L2 reading: student performance, student attitudes. *Foreign Language Annals*, **30**(1): 58–72.

Desmarais, L., Laurier, M. and Renié, D. (1998) The Analysis of Navigation Patterns in CALL. *CALL Journal*, **11**(3): 309–315.

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press

Ehrman, M. E. and Oxford, R. L. (1989) Effects of sex differences, career choice, and psychological type on adult language learning strategies. *The Modern Language Journal*, **73**(1): 1–13

Ehrman, M. E. and Oxford, R. L. (1990) Adult language learning styles and strategies in an intensive training setting. *The Modern Language Journal*, **74**(3): 311–327.

Garrett, N. (1998) Where do research and practice meet? Developing a discipline. *ReCALL*, **10**(1): 7–12.

Grace, C. (1998) Personality type, tolerance of ambiguity, and vocabulary retention in CALL. *CALICO Journal*, **15**(1-3): 19–45.

Grice, H. P. (1975) Logic and conversation. In: Cole, P. and Morgan, J. (eds.), *Syntax and Semantics*, vol. 3 Speech Acts. New York: Academia Press, 41–58

Hubbard, P. (2002) A Survey of unanswered questions in computer assisted language learning. http://www.stanford.edu/~efs/callsurvey/index.htm

Hwu, F. (2005) Spanish preterite and imperfect in conversations: The pragmatic meanings. *Journal of Languages and Linguistics*, **4**(2): 183–206

Jamieson, J. and Chapelle, C. A. (1987) Working styles on computers as evidence of second language learning strategies. *Language Learning*, **37**: 523–544

Jung, C. G. (1971) *Pscyhological Types*. Princeton, NJ: Princeton University Press.

Lawrence, G. (1979/1995) *People Types & Tiger Stripes*. Gainesville, Florida: Center for Applications of Psychological Type

Lawrence, G. (1984) A synthesis of learning style research involving the MBTI. *Journal of Psychological Type*, **8**: 2–15

Liou, H. (1997) Research of on-line help as learner strategies for multimedia CALL evaluation. *CALICO Journa*l, **14**(2-4): 81–96.

Meredith, R. (1978) Improved oral tests scores through delayed response. *The Modern Language Journal*, **62**: 321–327

Meunier, L. E. (1996) Human factors in a computer-assisted foreign language environment: The effects of gender, personality, and keyboard control. *CALICO Journal*, **13**(2-3): 47–72

Moody, R. (1988) Personality preferences and foreign language learning. *The Modern Language Journal*, **72**(4): 389–401.

Myers, I. B., McCaullley, M. H., Quenk, N. L. and Hammer, A. L. (1998/2003) *MBTI Manual. A Guide to the Development and Use of the Myers-Briggs Type Indicato*r. Mountain View, CA: CPP.

Oxford, R. L. (1990) *Language Learning Strategies. What Every Teacher Should Know*. New York: Newbury House Publishers.

Appendix A: Sample pre-post test question

Beth was teaching the Spanish comparative structure to her students. She used her students in her examples. In one example, she said, "*Cassandra es tan bonita como Sara*". Both students' faces turned red immediately. Beth quickly apologized. She SAID:

"***Oh, I did not want to embarrass you"***.

What **is/are** the best way/s to express the underlined phrase for Beth? If both are acceptable, circle both answers. Then, explain why you chose the answer/s.

a) Ah, no quería avergonzarlas.
b) Ah, no quise avergonzarlas.

Reason/s_____

https://doi.org/10.1017/S0958344007000316 Published online by Cambridge University Press