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Working Memory in Spanish–English and Chinese–English Bilinguals

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Abstract: Many researchers demonstrated the causal effect of bilingualism for working memory ability; bilinguals have higher executive functions in maintaining higher working memory ability. The present research examined the effect of different language types college bilinguals—Chinese–English (two dispersed languages) and Spanish–English (two similar languages) bilinguals for their working memory abilities. Chinese–English and Spanish–English bilinguals have been compared in many studies. Spanish–English bilinguals are superior learning English with similar consonant, vowel, alphabetic orthographic system and phonetic structure. Therefore, they are outperformed in many language-related tasks because they use less switching and transferring cost in both languages. On the other hand, learning English for Chinese-English bilinguals is much challenging because of the greater language structure differences. They need to visually practice in Chinese logograph and English alphabetic orthographic system to achieve high levels of competencies in both languages. Hence, it implies Chinese–English bilinguals acquire a higher working memory ability to deal with languages and daily tasks than those Spanish–English bilinguals who exercise working memory less in languages. To evaluate how language can shape on human's working memory ability without language proficiency issue, a visual working memory (Paper Folding Test) was presented. By comparing the visual working memory test scores, Chinese–English bilinguals scored statistically higher than Spanish–English bilinguals, while controlling for gender and self-reported English level. Further research should investigate the relationship between bilingualism and working memory, and continuously assess the definitions on very shared languages and very dispersed languages.

Keywords: Bilingualism, Working Memory, Paper Folding Test, Visualization, Chinese–English, Spanish–English

1. Introduction

The working memory plays an important role in a human's life to process information and manipulate it in order to guide their behavior [16]. Working memory activates the dorsolateral prefrontal cortex and frontal cortex, this is especially shown when looking at bilingual individuals, and their performance in working memory, language-switching, task-switching, and global inhibition tasks from numerous fMRI studies [10], [11], [16]. These fMRI results showed that they increased the executive function of cognitive processes while performing these tasks. Also, these studies imply that working memory relates to different languages of bilingual people who have high levels of competencies in two languages because bilinguals were included in all the aforementioned tasks. Kudo and Swanson (2014) also confirmed that bilinguals have advantages on executive components of working memory and cognitive processing [13].

The bilinguals were tested on various working memory tasks and their working memory ability compared to single language speakers. In a verbal and spatial working memory span task, the bilinguals exclusively performed better in spatial working memory than monolinguals, but not on the verbal working memory task [14]. Moreover, Morales, Calvo, and Bialystok (2013) conducted a research on bilingual children and found bilingual children outperformed on visuospatial working memory tasks and conflict resolution, supporting the idea that bilingual children grow up having a higher working memory capability than monolingual children [18]. They responded faster and more accurately in required working memory tasks, including visuospatial span tasks, Simon-type tasks and incongruent trials, which confirms the

advantages of bilinguals on executive functioning of working memory. When tasks distinctively contained executive function demand, bilingual children would do better than monolinguals overall and this showed the advantage for bilingualism in working memory.

Not only do bilingual children have working memory advantages, but also bilingual people of all ages also possess an increased working memory. Bialystok, Craik, and Luk (2012) indicated that bilinguals of all ages have better executive control because they already had a set of cognitive skills that built on limited cognitive resources for tasks such as inhibition, switching attention, and working memory [2]. The executive control is related to working memory, which is positioned in the bilinguals' frontal lobes among their neuronal network and associates with other brain regions in other specific tasks. After identifying the neural area on all ages of bilinguals, some researchers found that bilinguals with an incompatible level of language proficiency in both languages still have executive control on working memory advantage. Xue, Dong, Jin, and Chen's (2004) study was conducted to search non-fluent Chinese–English bilinguals, who had limited second language proficiency [24]. From the fMRI result, they were higher activated in their brains' opercular region, which controlled a large language effect on phonological and semantic tasks for non-fluent bilinguals to process semantic information. Xue, et al. (2014) continued to point out that non-fluent bilinguals had similar brain patterns on verbal working memory tasks with either first or limited second language, because Chinese and English are mediated by non-fluent bilinguals' unitary neural system in the frontoparietal region which increase their computational demands of the low second language proficiency on working memory tasks [24]. Hence, non-fluent bilinguals stimulated more areas of their brains for processing more working memory to meet the need of second language proficiency. Compared to the monolinguals, non-fluent bilinguals still have the equivalent working memory ability with the high levels of competencies in two languages since they need to process extra information in languages. No matter which type or the age of bilinguals, all of them are able to illustrate their working memory advantage.

To search more specifically on bilinguals in groups, there have been studies conducted primarily in Spanish–English and Chinese–English bilingual groups [3], [19], [20]. There are some differences in bilinguals' executive control advantage between Spanish–English and Chinese–English speakers. For example, Spanish–English bilinguals have smaller task-switching costs which in a faster speed of response, as well as more frequently switching languages than Chinese–English speakers [20]. In another task, the cross-language transfers were more accurate in Spanish–English bilinguals, however, Spanish–English and Chinese–English bilinguals both transferred word reading fluently [19]. Although Spanish–English and Chinese–English bilinguals have different talents, these two studies infer Spanish–English bilinguals have a greater advantage in switching or transferring languages and tasks, while the Chinese–English speakers need to devote more working memory effort on these tasks [19], [20].

Spanish–English bilinguals remarkably do not differ in the activation pattern between the two languages in the left and right hemisphere regions such as dorsolateral prefrontal cortex, supramarginal gyrus, inferior frontal gyrus and superior temporal gyrus, for naming actions [11]. However, there was increased intensity of activation in their dorsolateral prefrontal cortexes, which is the area of functioning working memory during the time of language switching process. This result is showing that their advantage of language-switching involves with increased general executive processing in working memory. On the other hand, not only do Spanish–English bilinguals have the ability for greater working memory functioning, but Chinese–English bilinguals do also. A study showed Chinese–English bilinguals had an association between conflict resolution and their working memory capacity on the operation-span task, Simon, and Simon switching memory tasks [23]. With these two sample groups of bilinguals, the Spanish–English and Chinese–English bilinguals, who with working memory advantage, have the phonological awareness to aid in the acquisition of literacy. They understand their metalinguistic ability and their bilingual influences on their cognitive development [3]. Yet, Spanish–English bilingual children did better on phoneme segmentation tasks than Chinese–English bilinguals. This is a result of Spanish–English bilinguals already promoting simple phonetic structure of the Spanish language, making it easy for them to transfer reading acquisition skill and phonological awareness from Spanish to English. They experienced the advantages of language switching and transferring when they were compared to Chinese–English bilinguals who had not been exposed to the phonetic structure. The language advantage of Spanish–English bilinguals causes unfairness on Chinese–English bilinguals in every language-based working memory task. Hence, this study examines the working memory advantages between Chinese–English (i.e. two dispersed languages) and Spanish–English (i.e. two similar languages) bilinguals in a visual-spatial instead of a language-based working memory task.

2. Literature Review and Hypothesis

A group of literature [13], [14], [18] regarding bilingual working memory with emphasis on executive tasks or working memory tasks indicated bilinguals have higher performance than monolinguals when looking at tasks of verbal and spatial working memory span task, visuospatial working memory tasks, conflict resolution, and individually administrated battery of tests. The research on bilinguals uses two distinct bilingual groups such as Spanish–English which are two similar languages, and Chinese–English which are two completely different languages, as participant samples [3], [19], [20]. There are many reasons for setting Spanish–English as two similar languages and Chinese–English as two completely different languages. First of all, the language

structures of Spanish and English are more similar than Chinese and English. Spanish speakers have an easier time learning English because they have the simple phonetic structure idea on English rather Chinese bilinguals do not [3]. Additionally, Spanish's sound structure of language is more similar to English than Chinese. The Spanish's consonant–vowel alternation is familiar with either Spanish or English speakers, but Chinese speakers do not, as their language is more focused on phonological and tonal structure. Chinese–English bilinguals are dealing with difficulties in languages since Spanish has a similar phonetic structure with English is an advantage. Thus, English as Spanish–English bilinguals' second language, which with similar phonological structure and alphabetic orthographic system, may have some advantages when learning to read in English. Chinese–English bilinguals speak English as their second language, and the phonologically and orthographically differences in languages may require additional help in understanding English language concepts, so they would need higher working memory capability to process language information. Studies showed Spanish–English bilinguals did better than Chinese–English bilinguals on many tasks and used less switching cost to process information [3], [19], [20]. This also suggests Chinese–English bilinguals may need to trigger a higher level of working memory on every task, in order to meet the language proficiency and compare with privileged Spanish–English bilinguals.

Despite the bilingual group comparison on working memory, age is another consideration when doing this research. A research study supports that bilingual college students have better metalinguistic awareness on their language skills in reading and working memory than monolinguals [21]. Certainly, bilinguals have more advantages than monolinguals, namely, bilinguals have greater executive processing in the working memory domain. The working memory advantage lasts from their childhood through their adult lifespans [14]. Nevertheless, bilinguals did greater than monolinguals in spatial working memory tasks but lower in the verbal working memory. It confirmed that bilinguals do not have verbal working memory advantages over monolingual individuals. In a more recent study, Bialystok, Poarch, Luo, and Craik (2014) reported bilingual adults have less interference effect when doing a Stroop task of executive functioning and discovered that they have more advantages in the nonverbal task and other tasks compared to younger adult group and monolingual adults [4]. Bialystok, Craik, Klein, and Viswanathan (2004) also observed a similar result, in which both middle-aged and older adult bilinguals group associated smaller Simon effect costs (i.e., the time needed to respond to the incongruent items) which they processed information and responded faster with greater demands in working memory [1].

For the college level bilingual students, once they gain experience in managing high bilingual demands, they can perform high cognitive ability under their higher cognitive control and longitudinally working memory capacity. Additionally, cognitive control outcomes vary by the mechanism recruited during bilingual management, and the amount of experience to manage bilingual demands [15]. A study from Gold, Kim, Johnson, Kryscio, & Smith (2013) also supported that older adult bilinguals outperformed monolinguals in perceptual switching performance, which required working memory process, while aging occurred to decrease activation in left lateral frontal cortex and cingulate cortex [8]. These researchers revealed age-related over-recruitment correlated with bilingualism and better task-switching performance; their study offsets aging declines in cognitive control process and neural efficiency, including working memory functioning.

Gender can also cause differences in working memory tasks, typically in visual-spatial ability. Goldstein, Haldane, & Mitchell (1990) found gender differences in cognitive ability have significantly influenced [9]. Males perform better in science and mathematically, and also figure out tasks spatially since childhood, so their ability of visual-spatial domain are higher than females. Blough and Slavin (1987) also verify that males perform more accurately on visual-spatial task than females [5]. Females tend to use more verbal precocity to apply verbal solutions to visual-spatial tasks, but males are more likely to use mental spatial strategy to solve visual-spatial tasks. As a result, females take more times and are less accurate in those tasks. Despite interest and strategy differences, biological deposition determines males' advantage on spatial tasks. Hormones influence the gender difference in visual-spatial ability too [12]. The higher level of testosterone provides higher spatial ability and excel better in the visual-spatial task. Since men contain more testosterone than women and more engaging in activities that foster those visual-spatial abilities, men benefit on visual-spatial tasks.

Therefore, this study hypothesizes that two different languages (Chinese–English) bilinguals have greater working memory on visual-spatial working memory domain than two similar languages bilinguals (Spanish–English), with controlling language proficiency and gender differences.

3. Methods

3.1. Participants

In this research, participants were recruited from a multi-cultural Western university. Participants were either Spanish–English bilinguals or Chinese–English bilinguals. They gave self-report language proficiency on their languages to identify them as bilinguals. Especially for Chinese–English bilingual participants, they were included both Mandarin–English and Cantonese–English bilinguals, because they performed similarly in most measures and collapsed in data to increase the power [19]. All, participants were recruited by email, social media, and face-to-face invitation. Participants could help with the recruitment by inviting their bilingual friends who meet the eligible types of bilingual criteria either Spanish–English or Chinese–English. This study used 61 bilinguals, in which are 32 Spanish–

English bilinguals (12males and 17 females) and 29 Chinese–English bilinguals (19 males and 13 females). All participants were above 18 years old for both male and female.

3.2. Materials

A hand-out survey was given to participants with demographic questions and self-rated proficiency in their languages. The survey aimed to get their basic information for measurement. The self-rated language proficiency questions were amended from the American Council on the Teaching of Foreign Languages (ACTFL) scale [6]. It included twelve ranges of speaking, writing and reading of language proficiency levels with descriptions. Participants rated their English, Spanish, and Chinese levels on the range from as a Native to None (see Appendix A).

After that, the working memory test was used to measure their working memory level, which was adapted from the Kit of Factor-Referenced Cognitive Tests by Educational Testing Service (ETS) [7]. There were 23 factors to measure people's cognitive abilities. This research focused on the visualization (VZ) factor. The test used was called the Paper Folding Test (see Appendix B).

3.3. Procedure

All participants passed the admission on college and their English level was confirmed before they were instructed to complete the hand-out survey and the Paper Folding Test. All participant consented to participate in this study. After participants finished the survey, the Paper Folding Test was distributed to participants. Once participants read all instructions and were prepared to be tested, they had 3 minutes for each part to finish the test. It had two parts with ten items on each. In total, the whole set of laboratory experiment took 15-20 minutes to complete. During the test, participants had to imagine the square paper being folded and punched, subsequently, chose the best option to fit with the fold and the punch after they mentally unfolded the paper. This required both mental rotation and performing serial operations for Spanish–English and Chinese–English bilinguals to perform their working memory abilities [7].

4. Results

In order to compare Chinese–English and Spanish–English bilinguals' working memory ability, the scores and testing time of a visual working memory task recalled by each participant in each instruction condition were determined. The scores were calculated by adding up the points the participant chose correctly and subtracting the number they identified incorrectly [7]. Meanwhile, the testing time of the task was in total 6 minutes (360 seconds). Participants were timed from the beginning to the end of the task. To test on both groups of bilinguals, gender and self-reported English level were controlled for. The mean scores of visual working memory task (with corresponding 95% of confidence intervals) for Chinese–English bilinguals is 12.27 (15.00-9.55) and Spanish–English bilinguals is 6.66 (9.19-4.13). Before controlling variables, there was no difference between scores or time of visual memory task and types of bilinguals. The mean scores of visual working memory task had a significant effect for types of bilinguals, $F(1, 57) = 6.13$, $p = .02$, $\eta_p2 = .10$, while controlling for self-reported level of English and gender. Comparison of the confidence intervals revealed that Chinese–English bilinguals differed from Spanish–English bilinguals. For the testing time, there was still no significant effect for types of bilingual, $F(1, 57) = 4.93$, $p = .49$, $\eta_p2 = .01$, with controlling for self-reported level of English and gender. Chinese–English bilinguals scored higher than Spanish–English bilinguals, but testing time did not differ between the two types of bilinguals.

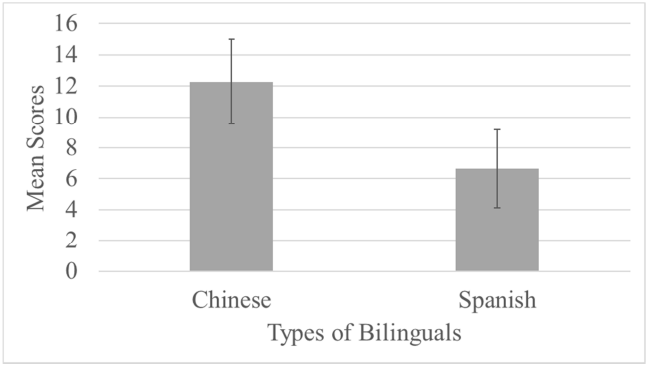


Figure 1. *The mean scores of visual working memory task on Chinese–English and Spanish–English bilinguals, with controlling gender and self-report English level. Error bars represent 95% of confidence intervals.*

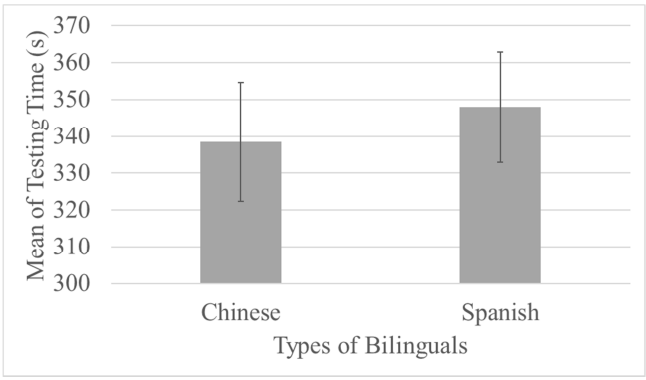


Figure 2. *The means of testing time of visual working memory task on Chinese–English and Spanish–English bilinguals, with controlling gender and self-report English level. Error bars represent 95% of confidence intervals.*

5. Discussion

The present findings indicate that Chinese–English bilinguals scored higher than Spanish–English bilinguals in the visual working memory task, when controlling gender and self-report English level. But, the amount of testing time did not differ between the two types of bilinguals. The findings support the hypothesis in that that two different languages (Chinese–English) bilinguals have a greater visual-spatial working memory than two similar languages

bilinguals (Spanish–English).

Indeed, language does influence working memory. A study supports similar finding where Chinese kindergarteners outperformed than Spanish speakers in visual-spatial task [17]. For those two dispersed languages learners, the language differences can promote them more visual working memory practices. Further, because of the language similarity on Spanish–English bilinguals, they are already familiar with English's consonant–vowel alternation, phonological structure, and alphabetic orthographic system [3], [19], [20]. Spanish–English bilinguals overall retain a higher language level in both languages, as they do better in switching and transferring languages. Spanish–English bilinguals have less working memory demands than Chinese–English bilinguals. In contrast, Chinese–English bilinguals dedicate more working memory to fulfill the huge differences in two languages. Chinese–English bilinguals need to do more routine rehearsals between Chinese logograph and English characters which provide a higher degree of a visual cognitive process than Spanish–English bilinguals with same alphabetic characters in Spanish and English [22]. Two dispersed languages can stimulate bilinguals to trigger higher working memory level and more switching costs to discriminate on two languages [3], [17], [19], [20]. Chinese–English bilinguals have a tough time learning both languages in reading and writing, plus, they need a high level of working memory to retain two languages accurately and fluently. Hence, it suggests that the more complex bilingual language combination, the higher working memory ability the bilingual speaker will acquire. Indeed, different types of bilinguals can differ in working memory level.

For the testing time, it is not significant between Chinese–English bilinguals and Spanish–English bilinguals. Because all participants were limited to three minutes for each part of the task, participants were time-limited and had no training. Furthermore, the present visual working memory test does not aim to measure their testing time and their fluency in the task. Instead, the purpose of this task was to evaluate one's scores within the limited time for predicting their visual working memory ability. The accuracy in the task is more notable in this research. Testing time does not interrupt with the analysis on bilinguals' working memory level.

To achieve a more accurate study, gender is one of the factors that should be focused on. In the visual working memory task, two bilingual groups can be swayed. For example, in a mental box folding task, females use comparison and are more analytical, but males just use the similarity strategy to clarify differences between standard and comparison form straightforwardly [5]. Males and females' cognitive thinking are different. And, this study does not obtain the equal numbers of men and females in each bilingual groups. If a group was dominated by male participants, it could skew up the scores to predict the working memory ability incorrectly. Meanwhile, gender differences among cognitive skills and spatial ability and men will be more confident to perform better in visual working memory task [12]. Thus, this study eliminated gender differences on testing for visual working memory.

The language proficiency is another factor that ought to be manipulated. Some participants have disproportionate proficiency levels in both languages, thus, the control of language proficiency was needed to measure the accurate differences between two groups of bilinguals. Controlling the language proficiency could effectively analyze the influences of merely learning in two dispersed languages or two similar languages to a person, aside from his/her language capabilities.

After controlling the gender differences and language proficiency, the study is able to show two dispersed languages learners acquire a higher working memory level to process visual and spatial information, such as arithmetic operations, geometry, science, and encoding words and letters in their correct order. Two different languages bilinguals have a greater visual-spatial working memory than two similar languages bilinguals.

6. Conclusion and Implications of the Study

The current result suggests individuals not only consider the differences between bilinguals and monolinguals, but also the differences within bilinguals. The varied bilinguals' types can determine people's learning ability. The greater dispersed languages bilinguals have learned, the higher working memory ability they could attain. It suggests that teachers and professors can take the bilingual differences into account when they are educating bilinguals. Bilingual students with two similar languages may request for more help on processing information among other types of bilinguals. To take into further deliberation, it is better to encourage and educate more dispersed languages to students because of the greater working memory advantage.

The limitations to this study are the first language problem and the confirmation of language proficiency. Most of the Chinese–English bilinguals are native Chinese speakers, but for the Spanish–English bilinguals, most of them are not native Spanish speakers. The participants of Spanish–English bilinguals speak English as their first language; thus, different first language among the participants may vary the result. Although all the Spanish–English bilingual participants learn and speak continuously in Spanish at least 2 years, it would be better to collect all native speakers as participants. Moreover, it is problematic to measure participants' actual language proficiency levels on each language. Apart from the college admission test that can confirm their English proficiency, there are no ways to evaluate their other languages' proficiency precisely.

Also, the study is absent for the monolingual group of Chinese participants to compare with the results and control the visual influence on Chinese characters. But, it is challenging to collect Chinese participants without learning any English, and previous studies have already shown that bilinguals have higher working memory than monolinguals

[14], [18].

In addition, future research should adjust and address these limitations. At the same time, it should continuously put more focus on why language differences and bilingualism can determine people's working memory ability. Further research can also define the concepts on similar languages and dispersed languages. It is necessary to assess the principles on very shared languages (e.g. two dialects within a country or two Western languages) and very dispersed languages (e.g. a Western language and an Eastern language) with bilingualism comparison. More researches need to be done on investigating the relationship between bilingualism and working memory.

Appendices

Appendix A

Hang-out survey

Please write down all your answer in the survey.

1. Gender: _____(Male/Female)
2. Age: _____
3. College year: _____ (freshmen/ sophomore/ junior/senior)
4. Home Country: _____ (e.g. San Diego, California, USA/ Beijing, China)
5. Your native language: _____
6. Your second language: _____
7. How long have you learned English: _____years
8. How long have you been in U.S: _____ years
9. How long have you learned Spanish/Chinese: _____ years

Please circle the test you had taken and write down the score of your test:

1. What is your English proficiency test score: SAT/TOEFL/IELTS/other test: (Specify: _____) _____

Please circle the best option to describe about your languages' level:

1. How would you consider your English level as:
   - Native: Able to speak like an educated native speaker
   - Distinguished: Able to speak with a great deal of fluency, grammatical accuracy, precision of vocabulary and idiomaticity
   - Superior: Able to speak the language with sufficient structural accuracy and vocabulary to participate effectively in most formal and informal conversations
   - Advanced Plus: Able to satisfy most work requirements and show some ability to communicate on concrete topics
   - Advanced: Able to satisfy routine social demands and limited work requirements
   - Intermediate – High: Able to satisfy most survival needs and limited social demands
   - Intermediate – Mid: Able to satisfy some survival needs and some limited social demands
   - Intermediate – Low: Able to satisfy basic survival needs and minimum courtesy requirements
   - Novice – High: Able to satisfy immediate needs with learned utterances
   - Novice – Mid: Able to operate in only a very limited capacity
   - Novice – Low: Unable to function in the spoken language
   - None: No ability whatsoever in the language
2. How would you consider your Spanish level as:
   - Native: Able to speak like an educated native speaker
   - Distinguished: Able to speak with a great deal of fluency, grammatical accuracy, precision of vocabulary and idiomaticity
   - Superior: Able to speak the language with sufficient structural accuracy and vocabulary to participate effectively in most formal and informal conversations
   - Advanced Plus: Able to satisfy most work requirements and show some ability to communicate on concrete topics
   - Advanced: Able to satisfy routine social demands and limited work requirements
   - Intermediate – High: Able to satisfy most survival needs and limited social demands
   - Intermediate – Mid: Able to satisfy some survival needs and some limited social demands
   - Intermediate – Low: Able to satisfy basic survival needs and minimum courtesy requirements
   - Novice – High: Able to satisfy immediate needs with learned utterances
   - Novice – Mid: Able to operate in only a very limited capacity
   - Novice – Low: Unable to function in the spoken language
   - None: No ability whatsoever in the language
3. How would you consider your Chinese level as:
   - Native: Able to speak like an educated native speaker
   - Distinguished: Able to speak with a great deal of fluency, grammatical accuracy, precision of vocabulary and idiomaticity
   - Superior: Able to speak the language with sufficient structural accuracy and vocabulary to participate effectively in most formal and informal conversations
   - Advanced Plus: Able to satisfy most work requirements and show some ability to communicate on concrete topics
   - Advanced: Able to satisfy routine social demands and limited work requirements
   - Intermediate – High: Able to satisfy most survival needs and limited social demands
   - Intermediate – Mid: Able to satisfy some survival needs and some limited social demands
   - Intermediate – Low: Able to satisfy basic survival needs and minimum courtesy requirements
   - Novice – High: Able to satisfy immediate needs with learned utterances

- Novice – Mid: Able to operate in only a very limited capacity
- Novice – Low: Unable to function in the spoken language
- None: No ability whatsoever in the language

Appendix B

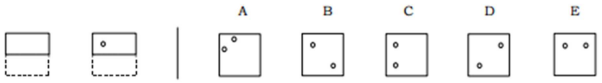
Paper Folding Test

The instruction page of the Paper Folding Test

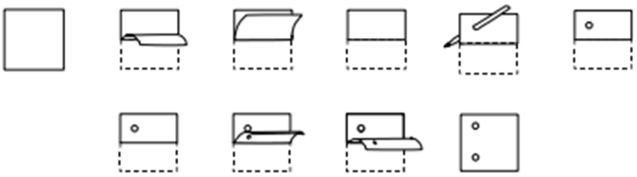
Paper Folding Test—Vz-2-BRACE

In this test you are to imagine the folding and unfolding of pieces of paper. In each problem in the test there are some figures drawn at the left of a vertical line and there are others drawn at the right of the line. The figures at the left represent a square piece of paper being folded, and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point. One of the five figures on the right of the vertical line shows where the holes will be when the paper is completely unfolded. You are to decide which one of these figures is correct and draw an X through that figure.

Now try the sample problem below. (In this problem only one hole was punched in the folded paper).



The correct answer to the sample problem above is C and so it should have been marked with an X. The figures below show how the paper was folded and why C is the correct answer.



In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.

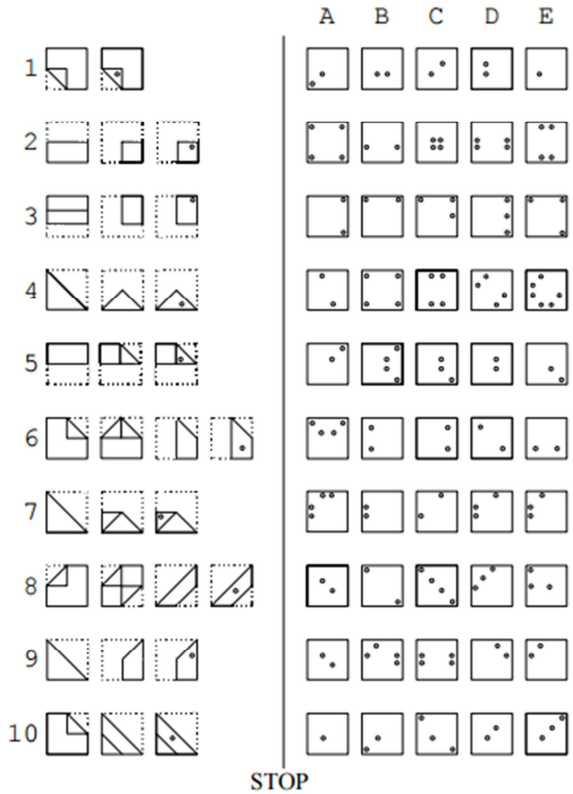
Some of the problems on this sheet are more difficult than others. If you are unable to do one of the problems, simply skip over it and go on to the next one.

You will have three minutes for each of the two parts of this test. Each part has one page. When you have finished Part One, STOP. Please do not go on to Part Two until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

The first part questions of the Paper Folding Test

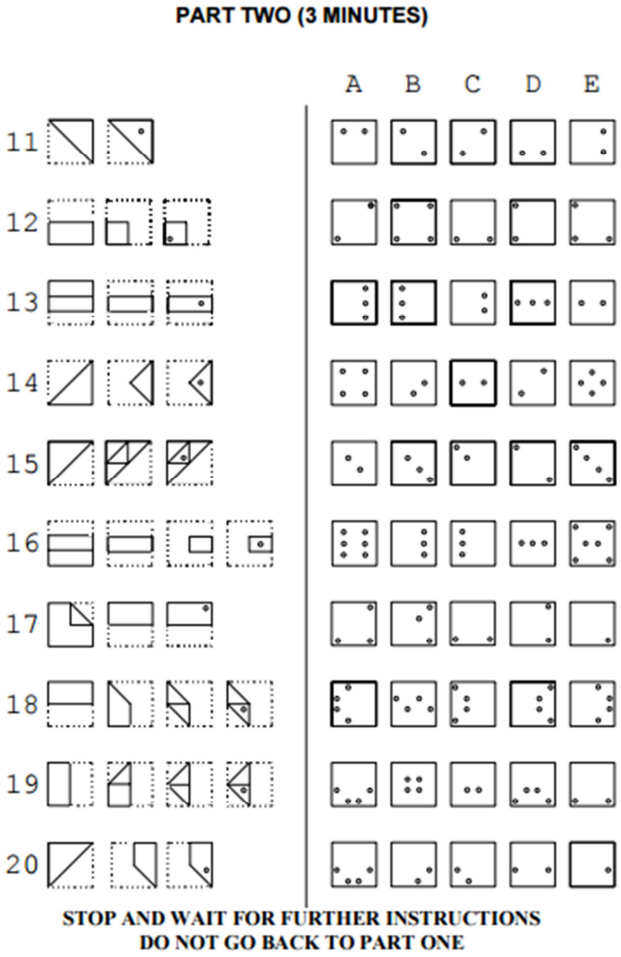
PART ONE (3 MINUTES)



STOP

DO NOT PROCEED TO THE NEXT PAGE UNTIL ASKED TO DO SO

The second part questions of the Paper Folding Test



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