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Survival Analysis for the Estimation of Additional Time as Accommodation on the Application of a Standardized Test

Análisis de sobrevivencia para la estimación de tiempo adicional como adecuación para la aplicación en una prueba estandarizada

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Abstract

This study presents a method for predicting the time required to complete standardized tests for populations that received accommodations, time is calculated according to variables related to the classification area and the approved accommodations. The population that took the Academic Aptitude Test (PAA) of the University of Costa Rica with accommodations between 2009 and 2011 was used as a sample. Parametric survival models, where the variables were the set of accommodations offered in each area, were estimated, and these variables were reduced by a stepwise process. Estimations of the time required for people classified into *learning* and *ADHD* areas, as well as certain subsets of the other areas, were obtained.

Keywords: accommodations, disability, measurement, assessment

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Resumen

Se presenta un método para la predicción del tiempo necesario para resolver pruebas estandarizadas por parte de una población que recibió adecuaciones, según variables relacionadas con el área de clasificación y las adecuaciones otorgadas. Se utilizó como muestra la población que rindió la Prueba de Aptitud Académica (PAA) de la Universidad de Costa Rica con adecuaciones entre el 2009 y el 2011. Se estimaron modelos de sobrevivencia paramétricos donde las variables fueron todas las adecuaciones ofrecidas en cada área, las cuales fueron reducidas mediante un proceso de *stepwise*. Se obtuvieron estimaciones de tiempo requerido en las áreas *aprendizaje* y *déficit atencional*, así como para ciertos subgrupos de las otras áreas.

Palabras clave: adecuaciones, discapacidad, medición, evaluación

The Academic Aptitude Test (PAA - *Prueba de Aptitud Académica*) of the University of Costa Rica (UCR) is a psychometric instrument that aims to measure general reasoning skills related to academic achievement in higher education. PAA items measure different skills as: induction, deduction, categorization, causal relationships, analysis, reading comprehension, quantitative analysis, analogical thinking, and interpretation, among others (Instituto de Investigaciones Psicológicas, 2007).

The origins of this test date back to 1957, when a need for an aptitude indicator for prospective UCR students was identified given the big amount of dropouts among the student body at that time. This test, which has been administered annually since 1970 as a screening instrument, was based, at the beginning, on the model of the Scholastic Aptitude Test (SAT) (Mainieri, 2010). However, PAA has evolved independently from it.

The PAA measures general reasoning skills in verbal and mathematical contexts. Its mathematical component uses a single type of item, while the verbal component uses two types of items: reading comprehension and sentence completion. The tested population must use their general skills to answer each item, to do so they need very basic knowledge (seventh year level of General Basic Education); that means that this type of measurement does not share the characteristics of an assessment applied on teaching and learning context (Montero & Villalobos, 2004).

The PAA is composed of *single-selection* items: a statement and multiple answer choices of which only one is correct (Montero & Villalobos, 2004). These items have been developed by a team of specialists and refined by applying scientific criteria in order to ensure the test's reliability and validity (Instituto de Investigaciones Psicológicas, 2007).

The PAA score corresponds to the percentage of correct answers (scale of 0-100), which comes from the grading of each item. Combining this score with the average grades earned by the person in diversified education (secondary education) gives the so-called *admission average*, which ranks people according to their performance and, based on this indicator, places them in categories of *eligible* or *not eligible* for admission to the university (Montero & Villalobos, 2004).

The PAA administration process at the University of Costa Rica must abide by current legislation about disability, and therefore provide accommodations in the test administration to people that require them, under the principle of equity and equal opportunities. The specific law that applies here is Law No. 7600 on Equal Opportunities for People with Disabilities (Asamblea Legislativa de la República de Costa Rica, 1996), which establishes the duty of educational institutions to provide the accommodations and to provide the support services required to ensure that people with disabilities can accomplish their right to education. This law also stresses the government's obligation to "eliminate actions and rules that directly or indirectly promote discrimination or prevent people with disabilities from gaining access to programs and services" (Article 4, subsection c) and to ensure timely access to education regardless of the disability (Article 14).

Another legal instrument that applies to accommodations in the administration of the PAA is the Convention on the Rights of People with Disabilities, ratified in Costa Rica as Law No. 8661 (Asamblea

Legislativa de la República de Costa Rica, 2008), which establishes the right of people with disabilities to equality and non-discrimination (Article 5) and to education (Article 24). It also establishes reasonable adjustments that promote the effective inclusion of people with disabilities in all areas of social life.

Brief theoretical reference

Standardization in the context of measurement is referred to a uniform management process, in terms of procedures and conditions, during the administration of a test. This is necessary for collecting comparable information on tested individuals (Georgia Department of Education, 2008). However, standardization can sometimes interfere with an accurate measurement of a person's level in the construct of interest because the format is not accessible for people with certain conditions. For example, a person with low vision who cannot properly access the text of the test items in the regular font size would have a low performance that would have nothing to do with his or her reasoning skills.

The causes of low performance on standardized tests by people with disabilities have been subject of questioning and discussion (Abedi et al., 2012; Thurlow & Wiener, 2000). A traditional approach would state that performance is exclusively associated with the organic characteristics of the person with disabilities. However, a newer approach would consider this performance as also related to a lack of prior educational opportunities and the barriers associated with having to take a test in a standardized application format (Cawthon, Winton, Garberoglio, & Gobble, 2011). This last aspect is intensified when the characteristics of the disability, as in the above example, do not necessarily have anything to do with the construct being measured and can lead to erroneous interpretations of the skill level of the assessed person (Cawthon et al., 2011).

The psychometric instrument's validity is ensured by guaranteeing, among other things, that if accommodations are provided, none of them compromise the technical quality of the construct measurement, i.e., they do not affect the difficulty of test, so that people who receive accommodations have no advantages or disadvantages compared to the rest of the population. This condition ensures that the assessed population's scores are comparable and that legitimate interpretations can be made about each examinee's level in the measured attribute (Messick, 1995). In short, this means that if an examinee is administered a PAA with less number of questions or with a lower level of difficulty, this person would receive a score that does not reflect his or her general reasoning ability, and his or her admission average would not properly predict his or her chances of academic success at the university.

As explained in the preceding paragraphs, attention to diversity is a current point of interest, and, as Alba and Zubillaga (2012) argue, it has grown in the last 30 years with the gradual process of recognizing diversity as a basic constitutive feature of the social fabric. Areas impacted by this point of view include the educative area, which is considered as a key for people with disabilities to achieve self-determination and independence, besides changing the mindset of people without a disability towards this topic.

This new model has impacted the UCR's admission process, and since 1980 the university has offered to people with disabilities or special educational needs accommodations in order to take the PAA (Universidad de Costa Rica, 1980). However, there is no research on the suitability of the accommodations for PAA's administration, or on the performance of individuals who receive them. This leaves an important gap regarding criteria for properly implementing the accommodations and regarding knowledge of their effect on the validity evidence for scores interpretation.

Because of the mentioned reasons, and because additional time for test taking is the most common accommodation granted for the PAA, a statistical analysis has been proposed to predict the time required to complete the PAA, according to the test taker's classification area[1] and some of the approved accommodations for each person. The extra time currently allowed may be 30 or 60 minutes, depending on the functionality that the test taker presents, via provided documentation or an assessment by the

[1] Currently, the clasification areas for the test takers who receive some kind of accommodations are: *learning*, *ADHD*, *visual*, *auditive*, *motor*, *emotional*, *systemic* and *multiple*. These areas have been defined by the Disabled Students Services Center (*Centro de Asesoría y Servicios a Estudiantes con Discapacidad* - CASED), the entity at the University of Costa Rica responsible for determining the accommodation requirements for each PAA test taker.

relevant university body. The amount of extra time offered to each examinee is determined by previous estimates related to the test completion time of the population that has received accommodations.

It is possible to find recent research on the granting of additional time and its effect on performance in problem solving. However, the results are contradictory with respect to this accommodation's "equalizing" effect on disabled people as compared to the non-disabled population. Some of these studies conclude that this accommodation, while improves performance by people with disabilities, also benefits people without disabilities performing the same tasks under the same conditions (for whom the accommodation should not make any difference).

One example of this is a research conducted by Lewandowski, Lovett, and Cohen (2013), who examined the effect of a time extension of 50% and 100% for the reading comprehension task in higher education students with and without learning disabilities. The results indicated that students without disabilities benefitted more from the overtime than the disabled group did, which the authors interpret as an indication that this type of accommodation is not suitable for this type of disability. However, students with disabilities who had extra time, especially those with 100% more time, far exceeded the scores obtained by students without disabilities who did not receive extra time.

The authors concluded that, given the effect of extra time on the test scores for the entire student population, unlimited time should be granted for tests in which speed is not part of the construct to be measured, while if speed is relevant to the construct measurement, the time accommodations should be granted only under very special conditions, so that those who have the accommodation but do not need it do not arbitrarily receive the benefit.

Similarly, Mandinach, Bridgeman, Cahalan-Laitusis, and Trapani (2005) examined the effects of additional time on performance on the verbal and math sections of the SAT Reasoning Subtest by students with and without disabilities. Specifically, they explored the impact of giving one group a standardized time, providing a second group with 50% more time, combined with defined breaks during test administration, and giving 100% additional time without any specific breaks during the test administration.

Although these authors found that the results for students with disabilities were not significant due to the small sample size, they found that students with disabilities (learning disability or Attention Deficit Hyperactivity Disorder [ADHD]) underperformed students without disabilities, regardless of the additional time allowed. The extra time seemed to affect the performance in the math section more than in the verbal part. For students without disabilities and with medium and high ability levels, the best performance was achieved when they were given 50% more time to complete the test, while the lowest performance was obtained in the standard time. For students with low ability levels, the extra time did not result in any type of advantage. Finally, 50% extra time benefitted all ability groups for the verbal section of the test, but the effects were not as marked as in the mathematical section.

Lesaux, Pearson, and Siegel (2006) found contrary results. These authors examined the effects of the extra time accommodation (indefinite time to complete the test) on performance on a reading comprehension test by a group of adults with disabilities affecting this area compared to a group of adults with normal reading levels. They found that all the participants with disabilities benefitted from the extra time, while the participants without disabilities had a similar performance to their performance without the accommodation. For individuals with disabilities affecting their reading abilities to a lesser degree, performance was not significantly different from that of the individuals without disabilities.

Cahalan-Laitusis, King, Cline, and Bridgeman (2006) conducted a similar study in order to provide information on the actual time used by students with learning disabilities and/or ADHD to complete the SAT. This information was compared with the information obtained from a sample of students without disabilities who completed the same test.

The sample of students with disabilities, who were given 50% more time to take the test, used more time to complete each section of the test than students without disabilities who took the test under standardized conditions (between 4% and 14% for the individuals with both disabilities, and in only a few cases was all the extra time used). This indicates that, although the total additional time was not necessary for the majority of the disabled sample, most students needed additional time for their test scores not to be affected.

According to this study, students with ADHD but without any learning disabilities generally did not need more time than that used by the non-disabled sample. However, higher time consumption was reported for the critical reading and mathematics sections. Moreover, some students with learning disabilities and ADHD were not able to complete the critical reading subtest; students with disabilities affecting their reading skills used 25% more time to respond to the first passage of this section.

In another study, Lee, Osborne and Carpenter (2010) compared the effects of a computerized test with the effects of a paper and pencil test, along with the effects of additional time for both formats, on the performance of students with ADHD.

Students who took the computerized version of the test scored significantly higher than those taking the paper and pencil version of the same test. While the amount of time that participants were allowed did not significantly affect their performance in either of the two test formats, it was, however, linked with a higher test score.

Finally, Cahalan-Laitusis, Morgan, Bridgeman, Zanna, and Stone (2007) sought to determine if students given additional time on the SAT Reasoning Subtest would suffer from excessive fatigue (measured by the increase in Differential Item Functioning [DIF] and the decrease in the rate of answered items) compared to students tested under standard conditions. The sample included students with learning disabilities and/or ADHD, as well as non-disabled students tested under standardized time conditions.

The results showed little change in DIF levels for the population with extra time. In addition, the rates of items answered for students receiving extra time was comparable with those of non-disabled students without additional time, which does not constitute evidence of an effect associated with excessive fatigue on behalf of the disabled individuals who received additional time for the test.

The results of the just mentioned studies show that the effect of extra time as an accommodation on standardized tests or on problem-solving tasks may be influenced by factors that are not yet determined and are related to the functionality of the individuals and the nature of the task. For example, while granting additional time may benefit people who have conditions that interfere with text processing, it can also harm people who have short attention spans. Thus there is a need for research on mechanisms that can define the amount of time needed for people in each disability area, according to the characteristics of each group.

With respect to the conceptual and theoretical development of accommodations on standardized tests, the issue of disability has historically been approached from different paradigms and models that have dictated how to care for people in this situation. Currently, actions to care for people with disabilities or special needs are based on the so-called *Social and Human Rights Paradigm*, which states that disadvantages, segregation, and lack of access to resources are not determined by biological impairments but by the social discrimination that people with these impairments experience (Puig de la Bellacasa, 1990), leading to a new definition of disability as:

> (…) an evolving concept that results from the interaction between people with impairments and the attitudinal and environmental barriers that hinder their full and effective participation in society on an equal basis with others (Asamblea Legislativa de la República de Costa Rica, 2008).

Similarly, people with disabilities are defined as:

> (…) those who have long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others (Asamblea Legislativa de la República de Costa Rica, 2008).

The social paradigm approach states that the problems and disadvantages that people with disabilities face are not originated on the inherent difficulties of their disability, but in the barriers found in the environment (Alba & Zubillaga, 2012). It also recognizes that culture and social rules are what determine which needs are valued and which are devalued, depending upon the dominant attitude of the time. Following this approach, the social environment has an obligation to remove barriers to access and communication, so that no organic impairment has implications beyond the physiological scope of the person (Ballestero & Vega, 2001; Montoya, 2003). This removal of barriers involves adapting the environment so that access to infrastructure and products and services can be guaranteed for all people within the society.

In the specific context of the PAA, this approach implies that people with disabilities should not have to adapt themselves to the requirements concerning access to the test's physical space and material, but rather the test administration rules should be amended and the presentation formats and physical conditions adapted in order to meet the specific requirements of people with disabilities or special needs without affecting the measurement of the construct.

Following this idea, accommodations are defined, in the context of a measurement, as changes in the measurement practices or instructions that reduce the impact of a person's disability in his or her interaction with the test material (Ketterlin-Geller & Johnstone, 2006). These can include changes in how the instructions are presented or how the measurement is made, the amount of time allowed to complete a task, the answering method, or the materials or equipment that enable interaction with the test material. To be considered effective, the accommodations must reduce the construct-irrelevant variance caused by the person's disability without affecting the construct measurement, i.e., they should not undermine the validity evidence in the interpretation of the scores derived from the test administration (Georgia Department of Education, 2008). Thus, the accommodations become attempts to "level the playing field" so that all the tested people have equal opportunities to show their skill level. These point to equity, not to an advantage for the group receiving them, by removing sources of construct-irrelevant variance, so that skill measurement is carried out with due precision (Abedi et al., 2012; Thurlow & Wiener, 2000).

According to the Georgia Department of Education (2008), only accommodations that are strictly necessary to ensure each person's access to the assessment should be granted, since providing unnecessary accommodations could negatively interfere with and impact performance and measurement. Additionally, accommodations made in assessment processes should adhere to the following principles:

- They should allow the examinee to participate fully in the assessment so that he or she can better demonstrate his or her knowledge or skills.
- They should be based on the individual needs of each person and not on a category or type of disability, level of education, or program of study.
- They should be properly justified and documented for each person.
- They should be in accordance with the accommodations that the person receives in his or her educational process and should not be introduced for the first time in the context of the assessment.
- They should facilitate the examinees' independence.

The concept of accommodations in test administration conditions can be confused with another concept that does have implications for the validity of the inferences made based on a person's results: the concept of modifications. Modifications are practices that change, alter, or reduce expectations of what is measured by the test. These can increase the gap between the disabled individuals' achievement and the performance expectations for the total group of examinees.

Modifications necessarily involve some impact on the construct measurement and, unlike accommodations, involve more than a change in the measurement scenario (Stone, Cook, Laitusis, & Cline, 2010). Examples of modifications in an assessment context include: lowering the assessment objectives, giving a test with less items or problems, allowing a person to complete only the easiest items, making a test easier, reducing answer choices on single-selection tests, or giving clues to the right answers (Georgia Department of Education, 2008).

Methodology

The data used in this article were collected by the Academic Aptitude Test Program (*Programa Permanente Prueba de Aptitud Académica*) in the span between 2009 and 2011 by asking test administrators to record the start and end time of each examinee. Subsequently, this information was integrated into a database containing the accommodations each examinee was allowed. To clarify, the end time is defined as the time when the person returns the test to the administrator and, due to the confidential nature of the test content, the administrators do not verify that the person has answered every item in the test booklet, but only verifies that the answer sheet is complete. Because of this, it is impossible to determine whether the person completed the entire test or marked random answers.

The combining together in one database of the population segments that took the test in the 2009-2011 span is justified by the way that the PAA is designed. The tests have conditions that remain constant year after year, for example: the difficulty (general and by component), the order of the items, and the number of items by area. This ensures that the tests corresponding to the years in question are very similar to each other (Programa Permanente Prueba de Actitud Académica, 2013).

Description of the statistical process

To estimate the time required in each of the accommodation areas, a survival analysis was done using STATA 11.0 software. The event was the completion of the test and the time corresponded to the number of minutes it took each candidate to complete the test. Using statistical terminology, the subjects who did not complete the test within the time allowed (which was three and a half hours, four hours, or four and a half hours, depending on accommodation) were considered censored data.

A parametric survival model was used in each area, and the predictors were the accommodations granted in each area. This model was refined by a stepwise process, whose entry criterion was that the p-value be less than 0.20. In each area, several complete models (with all the variables) were adjusted with different distributions (*Weibull*, *log-logistic*, *lognormal*, and *gompertz*). Then, using the BIC and AIC criteria, it was found that the distribution that best fit the data in all areas was the Weibull, except in *auditive* area, where the distribution with the best fit was the log-logistic (see Appendix B).

Then, the relevance of the selected distributions was graphically verified. For areas where the Weibull distribution was selected, there was a linear relationship observed between the logarithm of time and the logarithm of the cumulative *hazard* ratio (H), calculated by the Nelson-Aalen estimator. For *auditive* area, where the log-logistic distribution was used, there was a linear relationship between the logarithm of time and the logarithm of exp (H)-1, where H was again approximated by the Nelson-Aalen estimator. These linear relationships are necessary assumptions for using these distributions (Moeshberger & Klein, 2003).

For *systemic* and *multiple* classification areas, a joint stepwise was performed. The variables were the accommodations (both areas have the same accommodations) and an interaction of these accommodations with the *multiple* variable, which is 1 if the person is classified in *multiple* area or 0 if in *systemic* area. This process is performed when there are two groups with small samples and results are needed from each area separately, but with larger samples for the estimation.

The stepwise process for these areas was performed by pairs of variables (accommodation and interaction), where a pair was excluded only if both predictors had p > = 0.20. Moreover, as in most of the accommodation areas, combining these populations resulted in a better fit to the Weibull distribution than to the four other distributions.

Finally, it was decided to use an accelerated failure time (AFT) model, since the interpretations of its coefficients are easy to understand for readers not specialized in statistics. Appendix A shows that the coefficients obtained in the final models are consistent with those obtained in a Cox model, a widely used model in survival analysis, with the drawback being that it does not allow for time predictions.

In all models the basic assumption of the survival analyses was satisfied: the proportional hazards. This was verified by the *global proportional hazards test* and by a graphical comparison of the *hazards* of the population divided by sex (this comparison was considered relevant because gender is one of the variables with the most influence on PAA results, Rojas, 2013). In the first analysis, p-values greater than 0.05 were obtained for all models, whereas the graphic study showed that the quotient of the *hazards* of the two groups was a constant ratio.

For each completed adjusted model there was a graphical analysis of the Cox-Snell residuals against the cumulative hazard rate, and it was observed that these residuals do not deviate from the identity function, indicating that the model has a good fit (Moeshberger & Klein, 2003). On the other hand, in the residual plots of deviance against time, it was found that most of these residuals did not dramatically move away from the horizontal axis, providing further evidence of the good fit of the proposed models.

Predictors

As said above, the variables used as predictors in each area are the accommodations granted in these areas. All are coded as dichotomous variables, where 1 signifies the presence of an accommodation and 0 the absence of an accommodation.

The accommodations that are available to all areas are: enlarged font (font), calculator with basic operations (calc), special location (loca), mark answers in the test booklet (MarkX), administration in a group of 15 or 5 people (Small_G), individual test administration (Indiv), and multiplication tables (Table).

On the other hand, in *motor*, *systemic*, and *multiple* areas, there are several accommodations in common, such as an accessible classroom (Access), adapted furniture, (Furn), and a reader-transcriber (R_Tra).

In *visual* area, in addition to the general accommodations, there is also the use of a reader-transcriber (R_Tra) and other accommodations specific to the area, like test administration in Braille (Braille), use of a magnifying glass (Magn), special lighting (Light), audio test (audio), use of a talking calculator (T_Calc), and a specially-adapted form for the visually impaired (F5).

In *auditive* area, there are number of specific accommodations: use of dictionary (Dict), presence of oral interpreter (Oral_I), interpretation of the test booklet in Costa Rican Language Sign (LESCO), and a specially-adapted form for examinees with *auditive* accommodations (F6).

In *learning*, *ADHD* and *emotional* areas, there are no specific accommodations apart from the general ones offered to all areas.

Equations

After performing the stepwise process with the above predictors, the following equations for estimating time are obtained:

Learning: $t(S|Z) = \{\ln(1/S)\}^{1/p} * \exp\{\beta_0 + \beta_1 Font + \beta_2 Indiv\}$

ADHD: $t(S|Z) = \{\ln(1/S)\}^{1/p} * \exp\{\beta_0\}$

Motor: $t(S|Z) = \{\ln(1/S)\}^{1/p} * \exp\{\beta_0 + \beta_1 R\_Tra + \beta_2 Small\_G\}$

Visual: $t(S|Z) = \{\ln(1/S)\}^{1/p} * \exp\{\beta_0 + \beta_1 T\_Calc + \beta_2 MarkX + \beta_2 Indiv\}$

Auditive: $t(S|Z) = (1/S-1)^{\gamma} \exp\{\beta_0 + \beta_1 LESCO\}$

Emotional: $t(S|Z) = \{\ln(1/S)\}^{1/p} * \exp\{\beta_0 + \beta_1 MarkX + \beta_2 Table\}$

Systemic-multiple:

$t(S|Z) = \{\ln(1/S)\}^{1/p}$

$* \exp\{\beta_0 + \beta_1 Furn0 + \beta_2 Furn1 + \beta_3 Font0 + \beta_4 Font1 + \beta_5 Small\_G0 + \beta_6 Small\_G1\}$

Here, Z is a vector of values in the observed variables, S is the proportion of people for whom the event did not occur, p is the parameter of the fitted Weibull distribution, and γ, the log-logistic distribution.

Sample

This study has a cross-sectional design, since it uses the populations of three different years as a single population, composed of examinees who were granted an accommodation between the years 2009 and 2011. In *visual* and *auditive* areas, it was decided to eliminate the year 2009, since in this year a number of significant accommodations in the areas were not implemented (test in LESCO or use of talking calculator). Furthermore, it is important to mention that 1000 observations were eliminated from the analysis for two reasons: unrecorded times or "inflated" times due to the fact that some test takers were allowed to take breaks during the administration of the test.

Table 1 presents the absolute frequency of each area by year. It shows that each year *learning* area has the most accommodations, with just over 70% of all allowed accommodations. This is followed by *AHDH* area, then *visual*, *emotional*, motor, *auditive*, and *systemic* areas, and finally, *multiple* area.

Table 1
Absolute frequency of accommodations by area and year

Year	*Learn.*	*At. def.*	*Motor*	*Visual*	*Audit.*	*Emotio.*	*System.*	*Multi.*	*Total*
2009	619	120	22	-	-	40	19	5	825
2010	746	141	26	68	21	41	20	5	1,068
2011	848	123	23	64	30	51	19	8	1,166
Total	2,213	384	71	132	51	132	58	18	3059

Note: Source: prepared by the authors (2013).

Results and analysis

Table 2 presents the results of the models used to estimate the time needed to complete the PAA by accommodation area, except for *systemic* and *multiple* areas, which are given in Table 3.

As seen in the equations of the models, in *learning* area, only the accommodations of enlarged font (font) and individual test administration met the criteria for entry into the model.

Individuals with enlarged font accommodation different from that classified into *learning* area show significant differences at a level of 5% and on average take 10% less time than the other test takers in this area. On the other hand, examinees who require individual test administration take on average 34% longer than the population assessed in groups. However, this variable is not significant at 5%.

For people classified into *ADHD* area, it was found that none of the variables included in the analysis met the criteria for entry to the model. This suggests that for these subjects, none of the accommodations has a significant effect on the completion of the PAA.

For *motor* area, it was found that the small group accommodation shows a significant association at 1% with the PAA completion time, while the use of a reader-transcriber is significant at 10%. The presence of any of these accommodations is associated with more time used to complete the test.

Table 2
Models resulting from the stepwise by area of accommodation

Learning							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
Font.	-0.108	-10.232	0.042	-2.570	0.010	-0.190	-0.026
Indiv.	0.298	34.758	0.182	1.640	0.101	-0.059	0.655
Intercept	5.283		0.004	1183.240	0.000	5.274	5.291
ADHD							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
Intercept	5.280		0.010	528.840	0.000	5.260	5.299
Motor							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
R_Tra	0.153	16.532	0.081	1.890	0.059	-0.006	0.312
Small_G	0.278	32.080	0.083	3.360	0.001	0.116	0.441
Intercept	5.266		0.022	234.820	0.000	5.222	5.310
Visual							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
T_Calc	0.153	16.527	0.096	1.600	0.110	-0.035	0.341
MarkX	-0.461	-36.929	0.160	-2.880	0.004	-0.775	-0.147
Indiv.	-0.373	-31.108	0.147	-2.530	0.011	-0.661	-0.084
Intercept	5.798		0.162	35.800	0.000	5.481	6.116
Auditive							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
LESCO	0.341	40.635	0.062	5.480	0.000	0.219	0.463
Intercept	5.150		0.047	108.440	0.000	5.056	5.243
Emotional							
Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
MarkX	0.146	15.719	0.071	2.050	0.040	0.007	0.285
Table	0.305	13.566	0.222	1.380	0.168	-0.129	0.740
Intercept	5.340		0.026	206.320	0.000	5.289	5.391

Note: Coef: Coefficient, Perc_t: percentage increase over time, SE: standard error, z: Coef/SE, P>|z|: Associated probability that a value in the standard normal distribution is greater than or equal to the absolute value of z, Interval 95%: confidence interval at 95% for the coefficient. Source: Prepared by the authors (2013).

For population in *visual* area, it was found that the variables with significant effects at 5% were: marking answers in the test booklet and individual test administration. In addition, due to the selection criteria, the talking calculator variable was also included in the model. The coefficients of the marking answers in the test booklet and individual test administration variables indicate that, on average, examinees who used any of these accommodations require less time than the rest of the population in this area.

Meanwhile, for people with disabilities in *auditive* area, the variable marking significant differences at the 1% level is the administration of the test in LESCO. Examinees in this area that make use of the LESCO test spend on average 40% more time than *auditive* area population that does not use this accommodation.

Finally, for *emotional* area, only the marking answers in the test booklet accommodation has a significant effect, while the use of multiplication tables meets the criteria for inclusion in the model but has no significant effect. Furthermore, the use of both accommodations is associated with longer times to complete the test.

Table 3
Model resulting from the stepwise process in *systemic* and *multiple* areas

Time	Coef.	Perc_t	SE	z	P>|z|	Interval 95%	
Furn0	0.149	16.054	0.082	1.820	0.068	-0.011	0.309
Furn1	-0.260	-22.877	0.105	-2.470	0.013	-0.466	-0.054
Font0	-0.234	-20.883	0.100	-2.330	0.020	-0.431	-0.037
Font1	0.609	83.794	0.160	3.800	0.000	0.295	0.922
Small_G0	-0.070	-6.770	0.049	-1.420	0.155	-0.167	0.026
Small_G1	-0.169	-15.541	0.093	-1.810	0.070	-0.351	0.014
Intercept	5.335		0.037	146.020	0.000	5.263	5.406

Note: Coef: Coefficient, Perc_t: percentage increase over time, SE: standard error, z: Coef/SE, P>|z|: Associated probability that a value in the standard normal distribution is greater than or equal to the absolute value of z, Interval 95%: confidence interval at 95% for the coefficient. Source: Prepared by the authors (2013).

Table 3 shows the resulting model for the populations of *systemic* and *multiple* areas. In this table, because of the model's definition, the variables ending in 0 compared the *systemic* population with the accommodation specified in the first column to the *systemic* population without this accommodation. Similarly, variables ending in 1 compared *multiple* area population with the accommodation to the remaining *multiple* population.

For *systemic* area, the significant variables were the use of special furniture and enlarged font, the first one at a level of 10% and the second one at 5%. For the *multiple* area, the following significant variables were obtained: use of special furniture, enlarged font, and small group application. These showed a significance of 5%, 1%, and 10%, respectively.

The use of special furniture in *systemic* area is associated with more time, while in *multiple* area it is associated with less time. Conversely, enlarged font accommodation is associated with less time in the *systemic* area population and more time in *multiple* area. In both populations, the small group accommodation is associated with less time to finish the test as compared to individuals in the same area who do not use the accommodation.

Table 4 gives an estimate of the time at which 70% of the population completes the test by area and the accommodations selected by the stepwise process. In some sub-columns of the accommodation column, dots appear because the models selected less than three types of accommodations.

Table 4
Estimated time for 70% of the test population to complete the test by area and the accommodations selected in the stepwise

Learning						
N	Accommodations Font	Indiv.		Time	Interval 95%	
23	1	0	.	182.803	168.436	198.395
2,186	0	0	.	203.639	201.865	205.429
4	0	1	.	274.419	192.078	392.060
ADHD						
N	Accommodations			Time	Interval 95%	
384	.	.	.	202.719	198.791	206.724
Motor						
N	Accommodations Small_G	R_Tra		Time	Interval 95%	
48	0	0	.	198.456	189.922	207.373
5	0	1	.	231.265	198.578	269.333
18	1	0	.	262.121	224.187	306.475
Visual						
N	Accommodations T_Calc	MarkX	Indiv	Time	Interval 95%	
2	0	1	1	148.841	111..852	198.062
110	0	1	0	216.050	207.094	225.394
11	0	0	1	235.992	207.127	268.879
5	1	1	0	251.756	209.239	302.913
4	1	0	1	274.993	223.759	337.957
Auditive						
N	Accommodations LESCO			Time	Interval 95%	
26	0	.	.	192.182	175.102	210.928
25	1	.	.	270.275	249.800	292.427
Emotional						
N	Accommodations Table	MarkX		Time	Interval 95%	
102	0	0	.	217.183	206.439	228.485
26	0	1	.	251.310	220.553	286.358
4	1	0	.	294.730	191.316	454.044
Systemic						
N	Accommodations Furn	Small_G	Font	Time	Interval 95%	
1	0	0	1	169.026	139.289	205.112
2	1	0	1	196.161	160.589	239.612
30	0	1	0	199.177	186.681	212.509
6	1	0	0	247.937	213.651	287.726
Multiple						
N	Accommodations Furn	Small_G	Font	Time	Interval 95%	
3	1	0	1	278.053	221.744	348.663
1	0	0	1	310.660	240.915	400.598
1	1	1	1	218.944	179.746	266.689
1	0	1	1	244.619	199.391	300.105
4	1	0	0	191.217	165.942	220.341
4	0	1	0	168.224	141.814	199.552
Systemic and *multiple*						
N	Accommodations Furn	Small_G	Font	Time	Interval 95%	
23	0	0	0	213.640	198.877	229.500

Note: N: Number of observations in the sample that present each combination of accommodations. Source: Prepared by the authors (2013).

Next, the times that have time confidence intervals at 95% whose length does not exceed 50 minutes are given. In addition, *optimal time* is the term given to the average time it takes 70% of the population to finish the test (desired percentage of the population that completes the test) and *maximum optimal time* is the term given to the upper limit of the confidence interval at 95% of the optimal time.

For 70% of *learning* area population not assigned enlarged font or individual test administration, a maximum of 205 minutes is needed to complete the test (upper end of the 95% confidence interval), that is, less than three and a half hours. Meanwhile, for the individuals assigned an enlarged font accommodation but not the individual test administration, the maximum optimal time is 198 minutes. In *ADHD* area, on average, the desired percentage of the population that completes the test does so in 202 minutes, with a maximum duration of 207 minutes.

In *motor* area, individuals who are not granted a small group or reader-transcriber accommodation present a maximum optimal time of 207 minutes (less than three and a half hours, which is the minimum extra time allowed). Then, individuals in *visual* area who mark answers in the test booklet and do not use a talking calculator or individual test administration present a maximum optimal time of 225 minutes, or less than four hours (minimum extra time allowed). Similarly, *emotional* area population that does not use multiplication tables and mark answers in the test booklet presents a maximum optimal time of less than four hours (229 minutes).

With regard to *auditive* population, the maximum optimal time for those who are not granted LESCO administration is 211 minutes, while it is 292 minutes for those who do require this accommodation. This indicates that the maximum optimal time for the first group is about three hours and a half and nearly five hours for the second.

Finally, the population of *systemic* and *multiple* areas that did not use enlarged font or special furniture or applies into a small group has a maximum optimal time of 213 minutes. If the population belongs only to *systemic* area and does not use enlarged font or special furniture, but does take the test in a small group, the maximum optimal time is 230 minutes. In the two above cases, the time is less than four hours. For *multiple* area alone, there is no optimal time with an interval of less than 50 minutes long, but there are two cases in which the interval is about 55 minutes: when furniture but not small group or enlarged font is used or when small group is used, with no special furniture or enlarged font. For the first case the maximum optimal time is less than four hours, while for the second it is less than three and a half hours.

Other cases that can be considered are those that exceed the condition set at the intervals but which have more than 10 individuals. These cases are the *visual* area population that had an individual test administration and does not mark answers in the test booklet or use a talking calculator, *emotional* area individuals who do not use multiplication tables but do mark answers in the test booklet, and *motor* area population allowed small group testing. The following maximum optimal times are given for these groups: 268 minutes for *visual* (nearly four and a half hours), 287 minutes for *emotional* (just under five hours), and 306 minutes for *motor* (slightly over five hours). In all cases, the confidence interval is about one hour.

Discussion

The results obtained by this study offer some initial scientific evidence concerning the amount of time required to complete the PAA by an examinee with a specific accommodation, which is a step forward for the program, since thus far the time estimate has been made using only expert judgment and previous descriptive analyses of the data relating to performance over time used by the population with accommodations.

The PAA Program considers the provided time is optimal when at least 70% of the population completes the test in the maximum time allowed. The results presented are limited to checking to see if the extra time accommodation really brings equity for the disabled population compared with their non-disabled peers in terms of ability to complete and submit the PAA. The effect that the accommodations can have on PAA scores for the disabled population will be addressed in a subsequent study.

Learning area examinees are generally given three and a half hours to complete the test, which is very similar to the prediction for the 70th percentile of the population that does not require an accommodation with a significant effect over time (enlarged font or individual test administration). In addition, examinees in this area who have an enlarged font accommodation, but not an individual test administration, also present an optimal time of less than three and a half hours. This suggests that the specialists' assessment of the time required for these subjects was fairly on the mark.

Just like in *learning* area, the maximum optimal time prediction for the *ADHD* area was quite similar to the time generally granted to this population, which is three and a half hours. The results indicate that there is no accommodation for this area that requires a change in the time given to examinees.

Motor area examinees who do not require the small group or reader-transcriber accommodations and *systemic* examinees who take the test in a small group and do not require special furniture or enlarged font, need only three hours to take the test, according to the maximum optimal times obtained (in the PAA it is customary to round up to the nearest half hour). On the other hand, *emotional* area examinees who do not require multiplication tables or marking answers in the test booklet, as *visual* area examinees who mark answers in the test booklet and do not require individual test administration or a talking calculator, and the *systemic* and *multiple* examinees not granted a small group or special furniture or enlarged font should be given at least four hours to complete the test. The times granted to these populations are not standard and depend on the examinee's conditions; however, the analysis in this study provides criteria for the construction of these standards.

The estimates indicate that the time may have been overestimated for *auditive* area examinees who do not require LESCO, since the maximum optimal time is exactly three and a half hours and they are frequently allowed four hours. The reverse is true with those that take the PAA in LESCO: they are allowed only four and a half hours, when the maximum optimal time is approximately five hours.

Although the estimates made in this study justify that *auditive* area individuals with a LESCO accommodation are given five hours to take the test, this may not be a favorable accommodation for this population, since two additional hours to the normal administration time introduce factors that adversely affect examinees, such as physical and mental fatigue or distraction. If this is the case, it does not reduce the impact of the disability and is not a suitable accommodation (Ketterlin-Geller & Johnstone, 2006). This leads the PAA Program to consider other options for assessing this population, such as reduction of the test or administration in two sessions.

Furthermore, while time estimates were obtained for most of the population, for certain groups with very few subjects it was not possible to obtain a reliable estimate. There is a need to gather populations with a greater number of test administrations, since with only three administrations some groups did not obtain stable times.

With respect to the influence of the accommodations on the time needed to complete the PAA, at most three accommodations were chosen in the final models, which seems to indicate that many accommodations do not influence the test execution time. The enlarged font, small group, and individual test administration accommodations were selected in two models, but all three take opposite directions in each model. For example, the enlarged font is associated with a shorter time than the rest of the population in *learning* area and with increased times in *multiple* area.

Finally, this study provides a theoretical basis for estimating time for populations with accommodations, as well as some background information on the accommodations that have a significant association with the time needed to complete the PAA.

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APPENDIX A

Comparison of the models obtained with the Cox model

From a comparison of the coefficients obtained in the parametric models with those obtained in the semi-parametric Cox model, it appears that in both models the estimated values take the same directions. This comparison is given in Table A1. The proportional *odds* assumption required for the Cox regression was met in all models and variables with 95% confidence, and this was verified with the STATA stphtest.

For example, the percentage change in the enlarged font predictor time of the parametric model in *learning* area indicates that people in this area who receive enlarged font accommodation finish the test in 10% less time than the rest of the *learning* area population. This is consistent with the *hazard ratio* obtained in the Cox model, which indicates that *learning* area individuals with an enlarged font accommodation have *hazards* in completing the test 82.6% higher than those of the other subjects.

Based on the above interpretation, it can be deduced that the coefficients of the parametric model and the Cox model match if the percentage changes in time are negative and the *hazard* ratios are greater than 1, or if the percentage changes in time are positive and the hazard ratios are less than 1. Table A1 shows that in both models all the predictors used yield consistent results.

Moreover, the significance of all the coefficients in both models is very similar, except for the *reader-transcriber* predictor in *motor* area, which is significant at 10% in the parametric model but not in the Cox model, although in neither of the models is significant at 5%.

These arguments show that the Cox model provides evidence that the estimates made using parametric models are consistent.

Table A1
Comparison of the coefficients of the parametric model and the Cox model

Learning					
Time	Parametric model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
Font	-0,108	-10,232	0,010	1,826	0,009
Indiv.	0,298	34,758	0,101	0,204	0,113
Motor					
Time	Parametric model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
R_Tra	0,153	16,532	0,059	0,574	0,397
Small_G	0,278	32,080	0,001	0,186	0,006
Visual					
Time	Parametric Model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
T_Calc	0,153	16,527	0,110	0,491	0,125
MarkX	-0,461	-36,929	0,004	8,447	0,008
Indiv.	-0,373	-31,108	0,011	5,551	0,020
Auditive					
Time	Parametric model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
LESCO	0,561	75,238	0,000	0,147	0,000
Emotional					
Time	Parametric model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
MarkX	0,146	15,714	0,040	0,544	0,065
Table	0,305	35,706	0,168	0,239	0,156
Systemic and *multiple*					
Time	Parametric model			Cox model	
	Coef.	Perc_t	P>|z|	H. ratio	P>|z|
Furn0	0.149	16.054	0.068	0.418	0.099
Furn1	-0.260	-22.877	0.013	4.453	0.029
Font0	-0.234	-20.883	0.020	4.528	0.022
Font1	0.609	83.794	0.000	0.023	0.000
Small_G0	-0.070	-6.770	0.155	1.492	0.206
Small_G1	-0.169	-15.541	0.070	3.002	0.072

Note: Coef.: Coefficient, Perc_t: percentage increase over time, P>|z|: statistical significance of the coef. or the ln (H.Ratio), H. ratio: hazard ratio. Source: Prepared by the authors (2013).

APPENDIX B

AIC and BIC models with all the variables by area and distribution

Table B1 shows that in all areas, the models with lower AIC and BIC are those adjusted with the Weibull distribution, with the exception of *auditive* area, where the distribution with the lowest values in these indicators is the log-logistic.

Table B1
AIC and BIC of the models with all variables by area and distribution

				AIC			
Model	*Learn.*	*At. def.*	*Motor*	*Visual*	*Audit.*	*Emotio.*	*Syst.-mult.*
Exponential	3515.469	617.242	114.953	299.126	125.496	210.934	164.351
Weibull	829.846	121.666	11.552	88.034	20.344	115.837	38.812
Gompertz	873.015	127.261	14.026	96.617	26.407	119.964	39.315
Log-Logistic	894.776	139.639	14.673	88.100	14.715	117.1639	46.724
LogNormal	953.470	145.807	13.907	90.326	30.084	122.933	51.845
				BIC			
Model	*Learn.*	*At. def.*	*Motor*	*Visual*	*Audit.*	*Emotio.*	*Syst.-mult.*
Exponential	3559.032	635.693	131.161	339.485	144.814	231.695	209.357
Weibull	878.862	143.808	29.782	131.276	41.594	139.193	85.961
Gompertz	922.021	149.403	32.253	139.859	47.657	143.319	86.464
Log-Logistic	943.787	161.781	32.908	131.342	35.965	140.521	93.873
LogNormal	1002.488	167.950	32.134	133.568	51.334	146.289	98.994