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Time & Society

Effects of Gender and Age on Retrospective Time Judgements

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ABSTRACT. This study provides additional empirical evidence for research concerning the effects of gender and age on retrospective time judgements using data obtained from a Spanish database with more than 40,000 individual observations on time estimations. Statistical analyses were performed using the Levene F-test and the t-test of variances and means, respectively. The most important results of the study are as follows: (a) differences in time estimation in relation to gender largely depend on the age groups analysed, with greater differences observed in the younger age group; and (b) although there are some differences regarding age, they are related to certain age groups, particularly the youngest age group. KEY WORDS • ageing • continuous time • gender • retrospective

1. Introduction

Time is one of the important dimensions that controls our lives and the larger part of our behaviour. The ability to perceive and accurately estimate the passing of time is fundamental to adapting adequately to the environment which surrounds us (Block et al., 1998; Pouthas, 1999).

The way in which subjects estimate time has become a key question in the literature. Time can be estimated either prospectively or retrospectively. In the first case, prior to beginning the task, individuals are aware that they have to pay attention to the passing of time. However, in retrospective situations,

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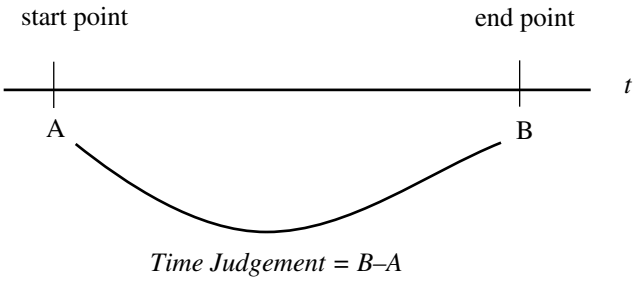


Figure 1
Retrospective Time Judgement

participants are unaware that they will be asked to judge the duration of a time period until after the fact. In each situation, time is estimated by means of different cognitive processes. In prospective situations, attention is directed at the passing of time, meaning that time is estimated by processing temporal information. In contrast, in retrospective situations, attention is directed at processing non-temporal information and time estimation is therefore based on remembering the information processed during the estimation interval (Zakay, 1990).

Questions such as 'How long did your favourite TV programme last?', 'How long was your last meeting with your boss?' are examples of retrospective situations requiring time estimations. In these cases, the task not only involves an exercise in computation, but memory as well. Thus a question such as 'How long have you been waiting for the bus?' demands that at least three tasks be performed: calculating the arrival time or the 'starting point' (see A in Figure 1), calculating the time when the bus was caught or the 'ending point' (see B in Figure 1), and calculating the difference between both magnitudes.

The different skills used by people to estimate the passing of time will influence their behaviour in various facets of their lives. For example, many goods and services have a temporal component which highly influences the perception and thus the evaluation of the good. Take, for example, purchasing a book through a website. The delivery time of the item is a crucial ex-ante variable which affects our decision to buy the book on one of the many online bookstores available on the web. And more importantly, once we have bought and received the book, it is our perception of the delivery time and not the delivery time itself which affects our decision to buy another book at the same bookstore or to switch to a different one. A similar line of argument applies, for example, when having dinner out. Our perception of the queuing time will affect our decision to have dinner out in the same restaurant again or to go to a differ-

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ent one. These two examples are meant to highlight the importance of time perception in evaluating a good or service and therefore in the economic behaviour of subjects.

Think now of several people trying to schedule their weekend. Their arrangements might involve leisure time, household duties and other activities. Again, the way they organize their weekend activities, that is, which activities will be accomplished and which will be postponed, will largely depend on the perceived duration of similar activities in the past. Thus, we find that people with the same available time react in different ways depending on their perception of time. In fact, several individual temporal dimensions that are affected by one's ability to estimate the passing of time (e.g. scheduling, punctuality, time buffers etc.) have been identified in the literature (see Francis-Smythe and Robertson, 1999 for a review). Hence, an analysis of individual time judgement will be crucial for our understanding of the dimensions that shape individuals' 'Time Personality'.

In a review of the literature, we have found many studies that identify the variables that affect or influence the time estimation task. These variables refer to both aspects of a methodological type and those related to the characteristics of the person estimating time. Factors of the methodological type include, among others, the methods used to carry out estimations (production, verbal estimation, reproduction and/or comparison),[1] the paradigm used (prospective or retrospective), the duration of the interval that must be estimated and the type of interval (if it is either a 'hollow' interval or has stimulating content, or on the contrary, presents some kind of stimulus or requires that the subject carry out some type of task). As regards personal characteristics, variables such as age, sex, activity level, education, expectations, motivation or personality characteristics, among others, have all been shown to be important in estimating time (e.g. Eisler, 1995; Angrilli et al., 1997).

Given that there are a large number of variables that can affect the time estimation task, study results largely depend on the type and design of the study and the methodology employed (for a review see Marmaras et al., 1995; Block and Zakay, 1997). This makes it difficult to extract conclusions from the different studies and even more so if they do not adequately describe the exact methods used (Zakay, 1993; Block et al., 1998).

Sex and age are two of the most commonly studied variables regarding time estimation. However, the results in relation to gender are quite confusing. Whereas some studies have found significant differences between men and women when carrying out different time estimation tasks (Bell, 1977; Delay and Richardson, 1981; Rammsayer and Lustnauer, 1989; Eisler and Eisler, 1992; Hancock et al., 1992; Espinosa-Fernández et al., 2003), others have not (Roecklein, 1972; Marmaras et al., 1995). Where differences were found between men and women, the general result has been that men are more accurate and homogeneous in their estimations than women (Block et al., 2000).

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Differences in time estimations have also been found with age. In a meta-analytic review (Block et al., 1998) it was found that older adults gave larger verbal estimates and made shorter productions than younger adults, although they made comparable reproductions.

In this article, we study both effects jointly. Despite the potential interest of this type of study insofar as it could provide additional evidence for experiments examining these effects independently, little research has been done along these lines (Block et al., 2000; Espinosa-Fernandez et al., 2003). From the methodological standpoint, a retrospective paradigm and a verbal estimation method are used here. According to Brown and Stubbs (1988), the retrospective paradigm offers at least two advantages over the prospective paradigm:

1. The average time under the retrospective paradigm seems to be more clearly related to the manner in which we normally perceive time since we rarely keep a constant eye on the clock or count while we are doing a task. According to these authors, retrospective procedures thus have a greater ecological validity.
2. Retrospective procedures can reveal the effects of variables which are not manifested in prospective methods, but which affect time measurements. The saying '*time flies when you're having fun*' implies that there is a difference in our perception of the duration of an interval depending on whether the events are interesting or boring. If we use the prospective paradigm instead of the retrospective paradigm, these events may not show a differential effect, since focusing attention on the time or using some counting strategy could minimize or even eliminate the difference in time estimations, in spite of the existing differences in the material presented.

We analyse data taken from a survey (this is explored in detail in Section 3) in which individuals were asked how long they had to wait before entering the doctor's office. Respondents were asked to give a numerical value (in minutes) to this time judgement. The database contains 40,000 observations.

Two-thirds of the observations involved a time task in which the starting point (A in Figure 1) was known. In other words, respondents knew the time of their appointment and simply had to calculate the difference between the time that they should have entered and the time that they actually entered, that is, the time that elapsed between the two. In this case, the time judgement was limited to guessing the actual moment of entry to the doctor's office.

The remaining observations correspond to individuals who went to the doctor's without an appointment and therefore did not have an exogenously fixed reference point or starting point (see Figure 1). One-third of the sample belonged to this group.

The most significant results of our study are as follows:

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1. Sex differences in time estimations mainly depend on the age group analysed, with greater differences observed in the youngest group;
2. Although there are some differences regarding age, these are related to certain age groups, especially the youngest ones;
3. The existence of a reference point, that is, the fact that the starting point is known or estimated, seems to be of little importance in time estimation.

The rest of the article is structured as follows. The difficulties involved in measuring time are examined in Section 2, while the database is described in Section 3. Finally, the results are discussed in Section 4 and conclusions reached in Section 5.

2. Measuring Time

Young and Ziman (1970) found that 'clock' or analogical time becomes continuous as a result of successive divisions. However, due to its particular nature, an analogical clock fractionally differentiates time and only through the continuous fragmentation of periods of time is it possible to perceive time as a continuum.

Unfortunately, fractioning time is not a simple task, especially when taking into account the bounded rationality of individuals. When individuals are asked to perform tasks involving computations in the continuum, they tend to simplify these tasks by using strategies such as '*round numbers*' or '*prominence numbers*'. The former strategy refers to the fact that individuals tend to round off magnitudes when performing operations. For example, the conversion from euros to dollars is usually done on a one-to-one basis even though the actual exchange rate varies daily. This 'rule' of equivalence between currencies is not due to a lack of information (current exchange rates can be easily found in any newspaper), but rather to the convenience of performing simple and straightforward calculation tasks.

The theory of prominence numbers is somewhat more complex. Based on a study by Albers and Albers (1983), Selten (1994) found that individuals encounter difficulties when performing numerical tasks in intervals of less than 10 units, while intervals of 2.5 are virtually impossible. Faced with this difficulty, individuals seek 'convenient' intervals to perform these tasks, which then become the determinant interval of their calculations. For example, suppose an individual is asked to calculate how tall Reinhard Selten is. First, the individual must set an interval, for example between 100 and 200 cm. Second, he will fix a middle point, say 150 cm. If there is no reason to think that Reinhard Selten is neither shorter nor taller than this middle point, the process will conclude. However, if the individual thinks, for example, that Reinhard Selten is taller, he will go back and fix a new interval, say between 150 and 200 cm. A new middle

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point of 175 cm will then be set and the individual will again decide if Reinhard Selten is shorter or taller. If the individual does not think so, he will stop. However, if the individual thinks Reinhard Selten is taller, he will recalculate the interval once again, setting it at 175–200 cm, and so on until there is no longer any reason to carry on.

Note that the new interval (175–200) is less 'manageable' as it contains decimal numbers, making the task more difficult. However, there is an additional problem. Could we have arrived at the same point if the initial interval was 160–90? The answer is probably not.

This example illustrates the *complexity of measuring magnitudes*. Let us return to the example of the bus given earlier. If an individual wants to know how long he has been waiting for the bus, he must first know when he arrived at the bus stop (*starting point* or A in Figure 1) and when he boarded (*ending point* or B). Only when both times have been estimated (hereafter α for A-estimated and β for B-estimated), will it be possible to calculate the time elapsed between both points.

When calculating the *starting point* (α), we encounter a similar problem to that involved in estimating Reinhard Selten's height. When did the individual arrive at the bus stop? Suppose the interval is set between 4 and 5 pm, the middle point would then be 4:30. If there is no reason for the individual to think that he arrived before or after this time, he will stop. But, if he thinks that he arrived before 4:30, he will go back and recalculate the interval, and so on. The same problem occurs when estimating the *ending point* (β). However, one last calculation remains to be done: the difference between both points: $TJ = \beta - \alpha$ (see also Sub-section 3.1).[2]

In short, a simple question of the type, 'How long did you take?' implies calculating when you started, when you finished and the difference between the two.

All of these operations or timing tasks make time estimation particularly complex. Given this complexity, individuals tend to use simple rules to facilitate their calculations. By using a methodology similar to that of prominence numbers, Brañas-Garza et al. (2003) have demonstrated that most respondents in the database use multiples of 5 when estimating time. Nevertheless, we should not overlook the fact that, in addition to these chronometric calculations, the time estimation task is influenced by different types of variables as we have already stated. These variables refer to both the methodological characteristics of the context in which estimations are made and the characteristics of the person who performs them.

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3. Database and Preliminary Considerations

3.1 Database

The database used in this study, 'Improving Patient Satisfaction', was compiled by the Institute of Advanced Social Studies (CSIC) in Spain with funding from the Department of Health of the Regional Government of Andalusia.

The sample was randomly selected from a representative population in the region of Andalusia. Between May 2000 and June 2002, 46,757 users of the region's public health care service were personally interviewed at the entrance to health centres. Each questionnaire consisted of 50 questions regarding the quality of service, user satisfaction with the treatment received by health care professionals, hospital facilities and so on.

Prior to analysing the data, it should be stated that there are two ways of arranging to see a general practitioner or paediatrician, by appointment or by number:

- The *appointment* system: patients previously request an appointment (by phone) for a set time and date. Note that the queue is not managed by a physician, but by a non-healthcare staff member. Therefore, personal characteristics and individual health status do not affect the individual's position in the queue.
- The *number* system: patients arrive at the health centre and 'queue up' until they are attended to. In this case, appointments are given on a strictly first-come, first-served basis.[3]

Henceforth, the first group will be referred to as the 'appointment' group, while the second group will be referred to as the 'number' group. Of the sample population in the database, 66.4% belonged to the 'appointment' group, while the rest belonged to the 'number' group.

3.2 Variables

Question P40 of the survey asked individuals who had made an appointment, 'How long did you have to wait from your given appointment time until you actually entered the doctor's office? X minutes'. For individuals who had not made an appointment Question P43 asked, 'How long did you have to wait from the time you arrived at the centre until you entered the doctor's office? X minutes'.

Given the difficulties associated with making time judgements (*TJ*) as seen earlier, we found that:

1. Respondents with an appointment (Question P40) knew their appointment time or the time that they were *supposed* to enter. Therefore, the *starting*

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TABLE 1
Gender differences

	Sample 1: Appointment			Sample 2: Number		
			Descriptive			
	# Subjects	Average	SD	# Subjects	Average	SD
Male	10,270	19.66	16.76	5,628	24.80	20.11
Female	16,943	19.29	17.33	8,004	25.38	20.49
			Tests			
		Stat.	P		Stat.	P
Variance	F-Levene	8.63	0.00	F-Levene	4.40	0.03
Average	t-test	1.72	0.09	t-test	–1.66	0.09

TABLE 2
Ageing effect

A) Descriptive	Sample 1 : Appointment			Sample 2 : Number		
Age group	# Subjects	Average	*SD*	# Subjects	Average	*SD*
< 21	2,360	21.17	17.58	1,080	25.72	20.83
21–30	4,570	20.17	17.79	2,012	25.66	21.01
31–40	4,772	18.42	17.03	1,996	24.49	20.69
41–50	3,079	19.63	17.11	1,567	27.23	21.52
51–60	2,941	19.17	17.11	1,483	24.42	19.94
61–70	5,049	19.32	16.77	2,906	24.24	19.10
71–80	3,738	18.83	15.90	2,166	25.04	20.23
≥ 81	704	19.84	17.58	422	25.75	19.14

B) Test	Sample 1 : Appointment		Sample 2 : Number	
	Levene	t-test	Levene	t-test
10–20 vs. 21–30	NR	R*	NR	NR
21–30 vs. 31–40	R	R	NR	R**
31–40 vs. 41–50	NR	R	R*	R
41–50 vs. 51–60	NR	NR	R	R
51–60 vs. 61–70	NR	NR	R	NR
61–70 vs. 71–80	R	NR	R	NR
71–80 vs. >80	R	NR	NR	NR

* a = 0.05; ** a = 0.10.

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point (A in Figure 1) was *known*. In order to estimate their waiting time, respondents were required to calculate the moment that they *actually* entered (β must be estimated by guessing) and subsequently compute the waiting time by calculating the difference between the *ex-ante* and *ex-post* entry time ($TJ = \beta - A$).

2. Respondents without an appointment (Question P43) faced a more complex problem. Not only did they have to calculate β, but also perform a similar task to estimate α (which is not given) After estimating both times, the difference was then calculated: $TJ = \beta - \alpha$.

The gender variable was included in Question CL1. Special importance was not given to obtaining an equal number of observations from men and women as the survey was designed with the objective of reproducing real user frequency at the health centres. However, little disparity was observed as 61.1 per cent of the observations corresponded to women (see Table 1).

The CL2 question corresponded to the age of the respondents. As in the question above, little importance was given to equal proportions across ages. Nevertheless, all age groups were well represented (see Table 2).

Finally, a total of 46,757 individuals were interviewed (including respondents with an appointment and those with only a number). These respondents gave waiting times in terms of time intervals, $t \in [0, 300]$ minutes. Given that the majority of the population is to the left of the interval, we decided to limit the sample population to respondents who gave times that were less than or equal to 100 minutes, $t \in [0, 100]$, leaving us with a total of 45,697 observations.

3.3 Additional questions

The research developed throughout the study is fundamentally based on the following two points:

1. The information collected from question 40 and question 43 refers to the time that the respondents said had elapsed. In other words, we do not know the real time, only the estimations given by the respondents themselves.
2. The objective of the study was to compare the population distributions which resulted from controlling the characteristic to be analysed (for example, gender). Using parametric tests, we were able to determine if these characteristics affect time estimation and whether or not the subjects came from the same population. That is, we analysed if this characteristic was significant.

This method might have been questionable had the sample been small, for example 100 subjects. Had this been the case, individuals with different characteristics would have waited for different periods of time. For example, all the women in the sample (50 if they comprised half the sample) would have waited

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longer than the men. However, given that the sample was randomly selected from a representative population of more than 40,000 observations, this situation is virtually impossible in statistical terms.

Before examining the results of the study, the following issues should be also considered:

1. A large majority of the respondents (43,740 or 95.7%) used *round numbers* when estimating their waiting time, that is, numbers ending in 0 or 5.
2. Out of the respondents, 40,845 used clock numbers (i.e. 0, 5, 10, 15, 30 and 60 minutes). In other words, 90 per cent of the respondents used analogical (discreet) time schemes (see Brañas-Garza et al., 2003 for a detailed analysis of this type of measurement).

In order to achieve the greatest possible homogeneity only the last group representing 90 per cent of the sample will be examined. Thus, statistical problems such as empty cells will be avoided and the study will be more general. Therefore, the sample will be limited to 40,917 observations.

Finally, prior to the analysis that follows, we will examine both samples (appointment and number) to determine if they do, in fact, have distinct distributions. The subjects in the 'appointment' sample waited, on average, for 19.43 minutes (SD = 17.12), while those in the 'number' sample waited an average of 25.14 minutes (SD = 20.34). In order to compare variances, a Levene[4] test was used (F = 670.33), indicating that the variances were different (p = 0.00). The t-test[5] of means also verified that the distributions were different (t = –28.15; p = 0.00). Hence, the observations did not come from the same population. This result is perfectly plausible if we consider that the use of reference points simplifies time estimation and leads to greater accuracy.

In the section that follows, the effects of gender and age on time estimation will be examined with relation to individuals with and without a reference point.

4. Results

4.1 Gender differences

Before discussing our results, we will briefly examine other findings supported in the literature. The meta-analytic review by Block et al. (2000) on retrospective time studies shows that sex differences do indeed exist. Women, in particular, were observed to overestimate time to a greater degree than men. Using a prospective analysis, Espinosa-Fernández et al. (2003) obtained the same gender bias in five-minute estimations, while Peters (1999) shows that time-allocation decisions are also different for males than females.

Thus, previous research shows that *females overestimate more than males*.

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Now we check if our data confirm this idea. We use the two samples: *Appointment* (when subjects have a previous appointment, that is, A is known in terms of Figure 1) and *Numbers* (subjects who do not have an appointment and therefore must wait in a queue, meaning that α is estimated). The descriptive and statistical analysis of the gender effect for both samples is shown in Table 1.

The vast amount of available data has led us to suppose, without any strong assumptions, that these data follow a normal distribution. With this distribution at hand, we may explore gender differences in two parallel ways.

4.1.1 Gender deviations with respect to the average

This part of the analysis allows us to determine whether or not females cause any gender bias, whereas *gender deviations with respect to the variance* illustrate gender-related skills, if any, when performing the timing task.

Let us now focus on gender effect on variance. The message is clear: both the *appointment* and the *number sample* indicate that *the variance is different* for males and females. In both cases, the Levene F-test rejected the equality of variance, indicating that there are, in fact, *differences between men and women in accurately estimating time*.

Thus, when comparing female/male variance (in both the appointment and the number sample) we may conclude that *men are somewhat more skilful at performing timing tasks*.

Given the large size of the sample, we were able to make some alternative sub-samples in order to determine if the effect continued to be ambiguous, or if it was possible to observe clearer differences. If the sample size is reduced to the response interval time, $t \in [0, 60]$[6] minutes, differences in variance among females and males persist. The latter is even more evident if the interval is further reduced, $t \in [0, 30]$.[7]

In sum, *regardless of the interval and the existence (or not) of reference points, males are more accurate in timing task*.

Let us now analyse gender effect on average (the so called gender bias). Table 1 shows that there are weak differences caused by gender in both samples (the t-test is only significant for $\alpha = 10$ per cent in both the appointment and the number samples). Thus, gender bias is not so evident. Interestingly, when the interval is reduced (60[8] minutes and 30[9] minutes), gender bias prevails only within the appointment sample. That is, when subjects perform timing tasks in 'small intervals' with reference points, males estimate time differently than females.

To summarize, *when the time intervals are very large, men and women estimate in a different way*. These differences prevail in smaller intervals when estimations include a reference point for guessing time; otherwise, there is no gender bias.

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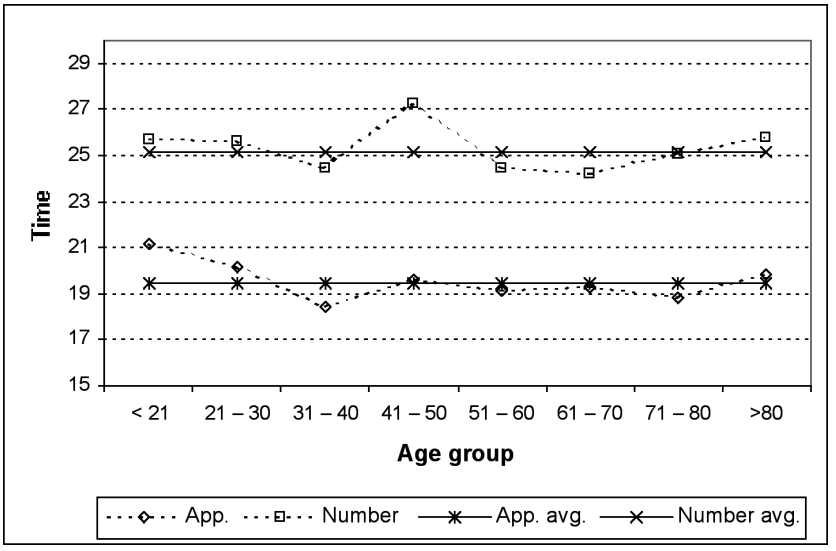


FIGURE 1
Ageing effect (sample 1 & 2)

4.2 Ageing differences

Evidence suggests that age affects time estimations. However, following Block et al. (1998), it should be noted that the age effect wholly depends on the method employed. For example, when a verbal method of estimation is used, elderly individuals overestimate, while the opposite occurs when using the production method.[10]

According to Fraisse (1984), the tendency of elderly individuals to underestimate is related to a loss of the neuronal capacity needed to perform these tasks. Thus, elder subjects may be less skilful at estimating time.

However, learning theory suggests the contrary. Subjects learn throughout their whole lives and their own experience may be extremely helpful. Thus, older individuals may possess certain skills in implementing their own rules of estimation; rules that have been perfected throughout their lives.

We will now check how age affects time estimations. We use the intervals proposed by Espinosa-Fernández et al. (2003) to classify individuals in relation to age.[11] The descriptive statistics are shown in Table 2(A), while a summary of the tests is given in Table 2(B).

Table 2(A) shows the average values by age group for individuals with a reference point (the *starting point A* is known) and without a reference point

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('number' sample) to estimate waiting time. These averages are graphically illustrated in Figure 2 for both cases. As can be seen, there are several peaks, meaning that there does not exist a clear pattern relating age to time estimation.

Both young individuals between the ages of 10 and 30 and the elderly (older than 81) give longer estimations. The same thing occurs with individuals between 41 and 50 years of age. It is interesting to note that the lower values correspond to individuals between the age of 31 and 40, whereas the remaining groups have intermediate values (see Figure 2).

The results of the statistical analyses are summarized in Table 2(B) (Sample 1). The rows show the comparisons between successive categories, while Columns 2 and 3 analyse the Levene test and the t-test (where NR accepts the null hypothesis, R is the full rejection, R* significant for $\alpha = 5\%$ and R** for $\alpha = 10\%$).

Within the *Appointment* sample (see Sample 1) we observe that whereas there are differences when subjects are under 50 years of age, no further significant differences arise for the 50 and above age group.

To sum up, although there are certain differences between age groups, no specific pattern regarding time estimation was observed. Therefore, this finding cannot be generalized as a negative trend associated with age. This result is, on the whole, in accordance with the findings by Block et al. (1998).

Similar results were found for the *Number* sample: there is no pattern of association between age and time estimation without a reference point. The results are basically the same with very few differences: *there are differences when subjects are under 60, whereas no further significant differences appear for older subjects.*

In sum, the only difference observed between Sample 1 and 2 was that young individuals behave differently. However, these differences do not provide much insight into the relationship between age and time estimation.

Finally, all the tests in Table 2(B) (Samples 1 and 2) and Figure 2 show that there exist certain differences between the young, adults and the elderly when estimating time. Taking into account that this relationship is neither decreasing nor increasing, it can be said that for some reason (we do not know why) certain age groups estimate time in a different manner. The tendency of the young, adults and the elderly to make longer estimations could be explained by the greater neuronal capacity of younger individuals, by the fact that adults are largely occupied (and, therefore, the opportunity cost of their time) and finally, by the accuracy of the rules used by the elderly which have been perfected over time. Interestingly, these effects are independent of the existence of a reference point.

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TABLE 3
Title

A) Ageing effect by gender group

Age group	Appointment				Number			
< 31 vs. 31–60								
Male	$F = 2.76$	(0.09)	$T = 4.26$	(0.00)	$F = 5.22$	(0.02)	$T = -1.56$	(0.11)
Female	$F = 4.66$	(0.03)	$T = 3.84$	(0.00)	$F = 1.53$	(0.21)	$T = 2.32$	(0.02)
<31 vs. older								
Male	$F = 7.59$	(0.00)	$T = 4.31$	(0.00)	$F = 0.30$	(0.58)	$T = -0.48$	(0.63)
Female	$F = 31.91$	(0.00)	$T = 2.95$	(0.03)	$F = 20.69$	(0.00)	$T = 3.16$	(0.00)
31–60 vs. older								
Male	$F = 1.30$	(0.25)	$T = -0.08$	(0.92)	$F = 11.24$	(0.00)	$T = 1.34$	(0.17)
Female	$F = 16.53$	(0.00)	$T = -0.88$	(0.37)	$F = 15.60$	(0.00)	$T = 1.01$	(0.30)

b) Gender effect by age group

Male vs. female	Appointment				Number			
Age group	Levene		t-test		Levene		t-test	
10 to 30 years old	$F = 3.51$	(0.06)	$T = 1.95$	(0.05)	$F = 10.27$	(0.00)	$T = -3.22$	(0.00)
31 to 60 years old	$F = 5.19$	(0.02)	$T = 0.87$	(0.38)	$F = 0.00$	(0.99)	$T = 0.29$	(0.77)
61 and older	$F = 0.00$	(0.95)	$T = 0.18$	(0.85)	$F = 0.01$	(0.89)	$T = -0.26$	(0.79)

Note. *p*-value between brackets.

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4.3 Age and sex

The prospective study by Espinosa-Fernández et al. (2003) jointly analyses the effect of age and sex on time estimation skills. However, little research along these lines has been done from a retrospective approach. Given that the database used here permits this type of comparison, we will analyse sex and age jointly in this last sub-section. Using the results from previous sections, we will limit our study to three age groups: under 31, 31–60 years of age and 61 and above.

The results of the statistical analysis are shown in Tables 3(A) and 3(B). First, we focus on the effect of age in the group of women. Sample 1 is studied in Columns 2 and 3, while the second sample is studied in Columns 4 and 5. Our comparisons are restricted to young women, adults and the elderly.

The results of the first comparison, young women vs. adult/elderly women, are evident: significant differences occur in time estimation between these age groups. It is clear that differences arise from the younger group of females. The differences in time estimation between younger and older women could be due to the different social conditions in which they live. For instance, older women (in contrast to younger ones) are more involved in family life and in the specific time experience of multiple times. They are more connected to quotidian temporal work (see, for example Davis, 1990).

In short, *differences in time estimation (with or without a reference point) across ages were only observed between young women and adult/elderly women*.

When we compare age groups of males we observe different results. Interestingly (and according to Section 4), the existence or not of a reference point plays a key role among males. Within the sample of subjects with appointments, there are differences when comparing young men and adult/elderly men. However, these differences were not observed when comparing adult men or adult women with elderly individuals.

The other sample of males (without a reference point) does not show any ageing effect. No significant differences were found between young men and adult males in time estimation, or between adult males and elderly males.

As can be seen, this result is analogous to that shown graphically in Figure 2. Thus very high values were observed for young individuals, while average values (either above or below the mean) were observed for the remaining age groups.

The populations in the above age groups (the young, adults and the elderly) are classified in Table 3(B) in order to once again explore gender bias. The following is a summary of some of the results:

- In the group of young individuals (under 31 years of age), significant differences were observed between men and women (for a value of α 5%);

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- In the adult group (30 < age < 61) gender biases in time estimation were not observed;
- Finally, no gender bias was found in the elderly age group.

In sum, *gender biases* in time estimation *with or without a reference point (A) occur at a young age.* However, from the age of 30 and above, this gender effect does not exist.

The lifestyle of the youngest individuals is, no doubt, a factor that affects the way in which they measure time. These results are practically identical to those analysed in the previous section. A gender bias was only observed in the group of young individuals, while no differences were found between men and women in the other age groups.

5. Conclusion

The objective of this study was to provide additional empirical evidence for the study of gender and age in time estimation using a retrospective paradigm. With this aim, a Spanish database with more than 40,000 individual observations on time judgements was used. Two-thirds of the observations corresponded to respondents who used a reference point (*starting point*) when estimating time, whereas the rest performed estimations with no reference point.

The sample was broken down by group according to the effect to be studied. The resulting distributions were then analysed statistically and compared using the Levene F-test and the t-test to determine the variances and means, respectively. The most significant results of the study are as follows:

1. Differences in time estimation related to age are relative. The most significant differences were observed when comparing young individuals and those older than 30 years of age;
2. There does not appear to be a clear relationship between age and time;
3. Gender bias is more pronounced in young individuals than in adults, regardless of the existence of a reference point.

These results are restricted to the specific methodology employed in this study. Recall that we have used the retrospective paradigm (the subjects did not previously know that they would be asked to estimate time) and the verbal estimation method. In these situations, memory plays a key role, since the time that is estimated is, in reality, remembered time. Individuals follow different procedures when making time estimates in these situations. On the one hand, and following the model by Ornstein (1969), individuals record and store input in their memory during a given time interval. Thus, the greater the amount of information or input that is processed, the longer the duration estimate. According to Block

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(1982) and Poynter (1989), the number of contextual changes that have occurred during the estimated interval is more important than the amount of input that has been processed and stored. As Poynter points out, in the absence of 'temporal receptors' that respond to a temporal stimulus, humans are aware of the passing of time through their perception of changes in the number, magnitude and significance of the events in an interval. The processing of these stimuli or events gives rise to temporal referents in one's memory which are used to reconstruct the duration of an interval. In addition to these memory referents, other factors that intervene in retrospective estimations include the information gained from previous experiences that is available to the subject in similar situations. If an event finishes (in this case when the waiting time to enter the doctor's office is up) later than expected, the time estimate will most likely be longer than if it finishes earlier than expected, in which case it will be shorter. A similar experience happens to many of us when we are bored and it seems as if time passes much more slowly, giving rise to longer duration judgements. Indeed, the differences found in our study in some age groups may be a reflection of the differential performance of some of these factors. It is interesting to note that after a given age, from 50 to 60, significant differences in duration judgements were not found between the groups. Furthermore, it is a well-known fact that the older one is, the more likely one is to visit health centres. This would lead to a greater understanding of the context and the situation, as well as greater experience and more opportunites to put one's expectations to the test as regards waiting times at the doctor's office. As a consequence, the duration judgements in these age groups are homogeneous.

On the other hand, given that data on actual waiting times were not available for our study, we only used the estimations made by the subjects themselves. Therefore, we cannot establish with any certainty whether the subjects overestimated or underestimated the interval. Following Brown and Stubbs (1988), we stated in the introduction that one of the advantages to retrospective paradigms is the greater ecological validity of the results. Thus, our study contributes to a better understanding of real-life situation. Nevertheless, we are aware of the fact that our results would have been more valuable had we known the real waiting time; an aspect that we intend to take into account in future studies. Future research projects will also include: (a) retrospective time task studies under lab conditions; (b) applications of the retrospective method for discrete variables (colours, race, etc.); and (c) the development of simple learning models to approach how subjects learn to estimate time.

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Notes

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1. *Production method*: the subject must define, in an operative manner, an interval of a given duration that has been verbally established by the experimenter. *Verbal estimation method*: the experimenter defines a time interval in an operative manner and the subject must verbally estimate its duration in seconds and/or minutes. *Reproduction method*: the experimenter defines an interval in an operative manner and the subject must then operatively reproduce an interval of the same duration. *Comparison method*: this is a variation of the reproduction method. The experimenter presents two intervals consecutively and the subject must judge their relative duration, saying which is the longest and which the shortest of the two.
2. Note that when the individual knows *ex-ante* the initial reference point (*starting point* or A) the problem is simplified. In order to perform time judgements, two possible strategies can be used: (a) estimating the *ending point* (β) and the difference between this point and A (which is known), $TJ = \beta - A$; and (b) using a shortcut: the subjective evaluation of the time elapsed without calculating the above difference.
3. This system is gradually being replaced by the appointment system and only occurs in health centres that have not yet established an appointment system.
4. Levene's test is an F test of the hypothesis that all factor standard deviations (or equivalent variances) are equal versus the alternative that the standard deviations are not all equal.
5. The t-test assesses whether the means of two groups are *statistically* different from each other. This analysis is appropriate for comparing the means of two groups.
6. Interval [0, 60]. *Appointment sample*: the Levene test weakly rejects the equality of variances ($F = 3.25$, $p = 0.07$). *Number sample*: the Levene rejects ($F = 7.36$, $p = 0.00$).
7. The first 30-minute interval: *Appointment sample*: the Levene test rejects ($F = 2.82$, $p = 0.09$); using the *Number sample* it also rejects ($F = 3.75$, $p = 0.05$).
8. Interval [0, 60]. *Appointment sample*: the t-test strongly rejects the equality of means ($t = 2.77$, $p = 0.00$); *Number sample* weakly rejects ($t = -1.67$, $p = 0.09$).
9. The first 30-minute interval: *Appointment sample*: strongly rejects ($t = 5.69$, $p = 0.00$); *Number sample* strongly accepts ($t = -0.02$, $p = 0.97$).
10. See also the recent paper by Aapola (2002).
11. There are two differences between the classification scheme proposed by Espinosa-Fernández et al. (2003) and the one used in this study: (1) the 8–10-year-old and 11–20-year-old groups were merged into one sample group as there were very few observations available for the first group; (2) due to the availability of data, a new category was added for > 81-year-old individuals.

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