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TIME PREFERENCES ACROSS LANGUAGE GROUPS: EVIDENCE ON INTERTEMPORAL CHOICES FROM THE SWISS LANGUAGE BORDER*

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Differences in patience across language groups have recently received increased attention in the literature. We provide evidence on this issue by measuring time preferences of French and German speakers from a bilingual municipality in Switzerland where institutions are shared and socio-economic conditions are very similar across the two language groups. We find that French speakers are significantly more impatient than German speakers, and differences are particularly pronounced when payments in the present are involved. Estimates of preference parameters of a quasi-hyperbolic discounting model suggest significant differences in both present bias (β) and the long-run discount factor (δ) across language groups.

Many important lifetime decisions, such as the degree of human capital acquisition, decisions about healthy lifestyles or pension savings, involve intertemporal trade-offs and are shaped by individual time preferences (Chabris *et al.*, 2008; Golsteyn *et al.*, 2014; Sutter *et al.*, 2013; Backes-Gellner *et al.*, 2018). Patience has also been shown to significantly correlate with economic outcomes at the country level, such as GDP per capita, the number of business start-ups or savings and human capital accumulation (Falk *et al.*, 2018). It is therefore important to gain an in-depth understanding of the nature, determinants and origins of time preferences.

In this respect, differences in patience across language groups have recently received increased attention in the literature. For example, using survey measures of patience in representative samples in eighty countries, Falk *et al.* (2018) found substantial differences in patience across countries and language groups. At a local level, Sutter *et al.* (2018) found stronger discounting among Italian-speaking children than German-speaking children in a bilingual Italian municipality, and Guin (2017) found that residents on the German-speaking side of the Swiss language border are more than 11% more likely to save than similar households on the French-speaking side. One potential explanation for such differences in preferences are cultural differences, which have been evoked as an explanation of various differences in economic behaviours across coun-

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tries and language groups (Alesina and Ferrara, 2005; Desmet *et al.*, 2009; 2012; Eugster *et al.*, 2011).

In this paper, we further our understanding of this issue. We experimentally elicit time preferences of two language groups, students in German and French school classes in a bilingual municipality in Switzerland, and measure short-run and long-run discount factors by systematically varying the time horizon.[1] This procedure allows us to not only compare language groups in patience, but to determine whether differences are driven by differences in long-run discounting or in present bias (Strotz, 1956; Laibson, 1997; O'Donoghue and Rabin, 1999; Frederick *et al.*, 2002).

An important feature of our paper is that we measure time preferences across two language groups that are highly integrated, similar in terms of socio-economic conditions, and that share the same institutions. Thus, we take advantage of an almost unique setting that allows us to keep many institutional and socio-economic factors—except the association to a language group—constant. In addition, we are able to directly account for differences in risk aversion at the individual level, which may differ by language group and have been shown to be an important determinant of discounting behaviour (Andersen *et al.*, 2008; 2014b).

Our results show that students in German language classes discount less than students in French language classes. Estimating preference parameters at the individual level, assuming quasi-hyperbolic discounting, we find differences in the long-run discount factor (δ) and in present biasedness (β) between language groups. Once controlling for a vast array of socio-economic and demographic characteristics of the students, these differences become statistically significant. In particular, our data suggest that the fraction of present biased individuals is around 10 percentage points larger among the French-speaking student population. Our data therefore show behavioural differences in intertemporal choice behaviour across the two language groups, with particularly pronounced differences in situations in which immediate payoffs are involved.

We find even stronger statistical evidence in favour of differences in time preferences between language groups from additional, non-pre-registered analyses. First, when looking at specific decisions between earlier and delayed payments, we find that, for example, while 41% of students in French language classes prefer CHF 16 today over CHF 20 in four weeks when present payments are involved, only 22% in German language classes do so, a highly significant difference of 19 percentage points. When faced with a choice between CHF 16 in four weeks and CHF 20 in eight weeks, the difference in the fraction accepting the earlier payment between the two groups shrinks to 9 percentage points. Moreover, we find that students in French language classes on average demand CHF 1.13 less to be willing to switch to the earlier amount when the earlier amount is paid today, a highly significant difference, but this difference significantly decreases to CHF 0.63 when the trade-off only involves future payments. Second, we additionally considered a utility specification assuming constant relative risk aversion instead of risk neutrality, thus directly allowing for curvature in the utility function (Andersen *et al.*, 2008; 2014b), and simultaneously estimated time and risk preference parameters using the generalised method of moments. The analysis reveals even stronger differences between language groups. The estimated long-run discount factor (δ) as well as present bias parameter (β) is significantly smaller for students in French language classes, both with and without socio-economic controls. This stronger finding is driven by the fact that, in our dataset, the French language group is on average less risk averse.

[1] Our study setting is a bilingual lower-secondary school in Murten, Switzerland, which is a bilingual city that is partly German and partly French speaking.

Our paper also contributes to the debate about the ultimate cause of differences in preferences and behaviours across language groups. Previous studies have linked such behavioural differences to culture, but culture is a multi-faceted construct, and it is difficult to pinpoint the precise mechanism through which culture affects preferences and behaviour. Chen (2013) highlighted one factor that is co-linear to cultural differences across language groups, and argued that languages that grammatically associate the future and the present might foster future-oriented behaviour.[2] To corroborate his hypothesis, Chen (2013) found correlational evidence consistent with a relationship between languages that grammatically associate the future and the present and future-oriented behaviour, such as higher savings rates, wealth and a healthier lifestyle. Other data are also consistent with this hypothesis: in the data of Falk *et al.* (2018), speakers of languages that grammatically associate the future and the present are on average more patient, and in Guin (2017) and Sutter *et al.* (2018), the speakers of such a language (German) display more patient behaviour.

Whether or not language structure is causal for the observed difference in patience remains unclear. On the one hand, not all attempts at finding an association between time preferences and language structure have been successful. For example, Chen *et al.* (2019) did not find effects on revealed time preferences in an experiment in which they exogenously vary the use of future tense in the Chinese language. On the other hand, the key problem in identifying such a causal mechanism is the intrinsic link between language and culture.[3] In fact, language is often used as a proxy for, or one aspect of culture — making it difficult to differentiate whether the observed differences are a direct consequence of language or of other cultural influences on future-oriented behaviour. Pointing to the importance of some cultural factors other than language, Roberts *et al.* (2015) found that the effect of language on future-oriented behaviour is weaker, but does not disappear, when controlling for the relatedness of languages and culture.

Because the grammatical association between the future and the present is stronger in the German than in the French language, our data can inform this debate in multiple ways. First Chen (2013) hypothesised that speaking about future events as if they were happening now leads to a perception of future events as less distant, and hence to discount less. However, such a change in tense only occurs for comparisons between the present and the future, but not for comparisons between two future events.[4] Consequently, if the perceived difference in distance induced by the language structure is the cause of measured differences in discounting across language groups,

[2] German serves as a good illustration of a language that grammatically associates the future and the present, as German speakers frequently refer to the future using present tense forms of verbs, e.g., 'es regnet morgen', which literally translates to 'it rains tomorrow'. On the contrary, French is classified by linguists to have a future-time reference. For example, 'Il pleuvra demain' would literally translate to 'it will rain tomorrow'. The hypothesis of Chen (2013) is based on the so-called Sapir-Whorf hypothesis (Boas, 1940; Sapir, 1949; Whorf, 1956) that postulates that language fundamentally affects our thinking. Close to that approach is the work of Boroditsky (2001), who showed that the native language one speaks influences how one thinks, especially about abstract domains like time. Her results suggest that language does not fully define individuals thoughts and thinking in the strong sense of the Sapir-Whorf hypothesis, but that language is a powerful tool, and certainly plays a role, in shaping abstract thoughts such as time.

[3] There are criticisms regarding the work of Chen (2013). Critiques have pointed to concerns regarding the classification of languages as associating the future and the present (Dahl, 2013), and there is a long-running debate surrounding the Sapir-Whorf hypothesis (Roberts and Winters, 2012). These critiques point out difficulties in identifying a true causal relationship from language structure to behaviour, partially questioning the plausibility of the hypothesis, partially pointing out factors that are co-linear to language, as well as the co-evolution of language and social environments. From an empirical point of view, we regard these debates as calls for more and better evidence to inform potential mechanisms.

[4] To illustrate this point more clearly, 'It will rain tomorrow' and 'It will rain the day after tomorrow' translate to 'Es regnet morgen' versus 'Es regnet übermorgen' in German, and 'Il pleuvra demain' versus 'Il pleuvra après-demain' in French. In German both events are referred to in the present tense, whereas in French both events are referred to in the future tense. Hence, there is no differential treatment *within* a language.

then such differences should in particular be present for intertemporal trade-offs that involve the present. Yet, neither the evidence in Chen (2013) nor in Falk *et al.* (2018), Guin (2017) or Sutter *et al.* (2018) can discriminate whether the observed differences in patience across language groups stem from uniform differences in discount rates, or are primarily a manifestation of differences in present bias. The fact that our results show stronger differences for intertemporal trade-offs involving the present is therefore consistent with Chen's hypothesis.

To further our understanding of the underlying mechanism, we distinguish between two specific channels through which language may affect behaviour and preferences.[5] First, students may have deeply held preferences, shaped by speaking a language over a long period of time. Second, behavioural differences may be caused by language cues at the moment of decision making. In particular, the use of present tense may reduce the perceived difference in time which in turn affects behaviour and revealed time preferences. In the first mechanism, the conflation of language and culture is rather clear: speaking a language over a long period of time is co-linear to being exposed to a language-specific culture over a long period of time. In the second mechanism, the conflation with culture is subtler. While the use of futured language may change the perception of distance, language cues could also trigger cultural cues, which in turn affect behaviour.[6]

If the first mechanism is correct, the true association in the data should be between native language and time preferences. Our main analysis, however, has focused on class language. While there is a significant correlation between students' native language and the language in which they attend classes, the correlation is not perfect. Hence, using class language as the regressor when the correct specification should have been native language would lead to attenuation bias. Consequently, a regression on native language should produce stronger results than a regression on class language. However, our data do not confirm this prediction. Estimated differences in time preferences become smaller rather than larger. Our data therefore do not provide support for the hypothesis that differences are caused by long exposure to speaking a specific language, or being exposed to a language-specific culture over a long period of time.

To assess the second mechanism, we focus on a subset of bilingual students. Arguably, this group has been exposed to both languages over a long period of time, but the elicitation of preferences took place in their class language, which was either French or German. Hence, if differences by class language persist, it is an indicator that language cues may be an important factor in explaining the differences. Indeed, we find that bilinguals in French classes are significantly more present biased. Differences in long-run discounting become slightly smaller than in our analysis using all students, but also remain significant in most specifications. While our data do not allow us to draw definite conclusions regarding the underlying mechanism, the evidence appears more consistent with an association between language cues at the moment of decision making and revealed time preferences.

Our results relate to recent studies of differences in economic outcomes between language groups (Eugster *et al.*, 2011; Brown *et al.*, 2018), and might provide a microfoundation for observed behavioural differences. For example, Eugster *et al.* (2017) showed that French speakers display significantly longer unemployment spells than German speakers along the language border in Switzerland, despite an integrated labour market and cross-language-border labour mobility. DellaVigna and Paserman (2005) theoretically and empirically demonstrated that longer

[5] Note that the analysis of these two mechanisms was not pre-registered.

[6] A related discussion regarding gendered objects focuses on the effects of grammatical gender distinctions as a possible source of, for instance, persistent gender disparities in employment, wage or of the household labour share (Milles, 2011; Mavisakalyan, 2015; Gay *et al.*, 2018; Shoham and Lee, 2018).

unemployment spells can be related to differences in present bias, and Backes-Gellner *et al.* (2018) provided empirical evidence that more present biased apprentices are indeed less likely to obtain job offers a few months before completion of their apprenticeship program. Our finding of differences in present bias across language groups might therefore provide a potential microfoundation for the observed differences in unemployment spells in Eugster *et al.* (2017).

In addition, Erhardt and Haenni (2018) showed significantly higher firm start-up rates among founders in Switzerland with German rather than French-speaking origin. Theories of entrepreneurship predict that higher patience is associated with a higher likelihood to become an entrepreneur (Doepke and Zilibotti, 2008; 2014), and Andersen *et al.* (2014a) found that entrepreneurs are indeed more patient than non-entrepreneurs. Our evidence therefore suggests that one reason behind the differences in Erhardt and Haenni (2018) could be the observed difference in patience demonstrated in our data.

Finally, our paper also relates to the literature that studies the impact of religion, in particular Protestantism, on economic behaviour and outcomes (Weber, 1930). At the language border considered, the French-speaking population has traditionally been predominantly catholic, whereas the German-speaking population has been more often protestant. Protestantism could therefore also be a potential cause for the observed differences in patience. Indeed, Basten and Betz (2013) found significantly lower preferences for leisure in the historically predominantly protestant area of Murten, compared to a predominantly catholic (and German-speaking) region situated in the same canton (administrative unit), and attributed this difference to religion. However, we believe that religion is an unlikely explanation of the observed differences in time preferences in our study. First, it would again primarily imply an association between native language and time preferences (rather than class language), which is not the primary association that we observe. Second, other recent work suggests that it is economic conditions that foster patience over time, rather than religiosity (Doepke *et al.*, 2005; Doepke and Zilibotti, 2008; Cantoni, 2015). Arguably, economic development might thus be an important mediator in the development of time preferences, and Basten and Betz (2013) also documented differences in this regard. We can control for this aspect since we compare French- and German-speaking individuals within the Murten school district, where economic conditions are very similar, and in addition are able to include controls for prosperity as well as specific cultural values that might have been shaped by religion at the individual level.[7]

The remainder of the paper is organised as follows. In Section 1 we describe the institutional background. In Section 2 we describe our experimental implementation, preference measures, procedures and hypotheses. In Section 3 we report the results. Section 4 concludes.

1. Institutional Background

In our analysis, we focus on students from a single school located in Murten, a bilingual municipality in the bilingual canton of Fribourg. Since policies and institutions are predominantly set on the Federal or Cantonal levels, people living in a bilingual canton experience the same political and institutional environment, but belong to different language groups. In the canton of Fribourg, 69% of the population speak French and 27% speak German (Swiss Federal Statistics

[7] Unfortunately, we were not allowed to elicit religious denominations at the individual level in our study. However, we asked whether religiosity is encouraged by the parents. Only 7% of the students agreed.

Office, 2016). Since 1857, both languages are recognised as official languages of the canton.[8] Murten has been bilingual, predominantly German speaking, for centuries. As a result, the two language groups are deeply intertwined and share the same institutions.[9] The majority of the French-speaking population is catholic (25% of the population in Murten), whereas the majority of the German-speaking population is protestant (44.5% of the population in Murten).

In school, German is the first foreign language taught to French speakers, and vice versa, and lectures start at the age of 8. As a consequence, while most inhabitants clearly identify with either German or French as their native language, the great majority of them speak the other official language very well, implying that language is hardly a barrier for social mobility in the region. Inhabitants celebrate the same festivals, such as, for instance, the Murten Lights festival or the Youth festival 'Solennitt'[10] that are equivalently animated in both languages.[11] They also attend the same sport and social clubs.[12] The labour market is also integrated across the language border. For example, there is substantial commuting over the language border, and there are no differences in labour market condition indicators, such as earnings, job separation rate, the unemployment inflow rate, vacancies per worker or job growth (see Eugster *et al.*, 2017).

Sixty-eight percent of students in the lower-secondary school in Murten attend classes in German and 32% in French, which closely represents the language composition of the local population. School attendance is compulsory and according to the place of residence. Consequently, students in our sample school are not selected on other criteria than residence.

In summary, the Murten school provides an ideal setting to assess behavioural differences between language groups in an environment in which institutions as well as the labour market are shared across language groups, and in which socio-economic conditions across language groups are highly comparable.

2. Experimental Design, Theory and Hypotheses

Our experiment aims at identifying differences in time preferences across language groups. Since Samuelson (1937), exponential discounting has been commonly used in economics to analyse intertemporal choices. Exponential discounting implies that future events are discounted by a constant factor for every unit of time until the event. The exponential discount function is given by $D(t) = \delta^t$. Consequently, individuals discount future outcomes by a factor that increases exponentially over time. A crucial feature of the exponential discount function is that it implies time consistency. The model allows for individual heterogeneity in patience through differences in the exponential discounting parameter δ.

Moreover, because of time consistency, one would expect that discount factors depend only on the time distance between the relevant events, independent of how distant these events are from the moment of decision making. However, it appears that people consistently consume more or exercise less tomorrow than they anticipate today. Such behaviour is inconsistent with the exponential discounting model. Behaviours revealing such present bias can be explained

[8] German was the official language from 1483 to 1798. Between 1798 and 1856, German and French alternated as official languages. See http://www.fr.ch/ww/de/pub/andere_links/zweisprachigkeit.cfm#i118897.

[9] See http://www.murten-morat.ch/de/portrait/zahlenundfakten/zahlenfakten/.

[10] See https://www.festivaldeslumieres.ch/; https://www.regionmurtensee.ch/en/P7969/youth-festival-solennitaet.

[11] This is nicely illustrated by this short video of the 2018 Murten Lights Fesitval https://www.youtube.com/watch?v=_otvXFXbbpU.

[12] See, for instance, the bilingual websites of the soccer and tennis clubs and for yoga classes, https://club.football.ch/club/home.aspx/v-753/; https://tsc-murten.ch/fr/bienvenue/; https://www.yoga-murten-morat.ch/bienvenue/.

if people put additional weight on immediate outcomes relative to outcomes occurring in the future. To capture such behaviour theoretically, hyperbolic discounting has been introduced into the literature by Strotz (1956) and Laibson (1997). A functional form satisfying the assumptions of hyperbolic discounting is $D(t) = (1 + \alpha t)^{-1}$. Such a discount function implies a declining rate of time preference (see, for example, Frederick *et al.*, 2002 for a survey). A particularly simple version of hyperbolic discounting, the so-called quasi-hyperbolic discounting model (Phelps and Pollak, 1968; Laibson, 1997; O'Donoghue and Rabin, 1999), is given by

$$D(t) = \begin{cases} 1 & \text{if } t = 0, \\ \beta\delta^t & \text{if } t \geq 1. \end{cases}$$

This model differentiates between two time discounting parameters, a 'classical' exponential discounting parameter δ and a present bias parameter β. Individuals with $\beta = 1$ are time consistent exponential discounters, those with $\beta < 1$ are present biased and those with $\beta > 1$ are future biased. Our experimental elicitation of time preference parameters, which we introduce next, is designed such that it can identify the two parameters in the quasi-hyperbolic model.

2.1. *Experimental Measures*

We use incentivised choice experiments to elicit time preferences of students. To this end, we employed two multiple price lists in which students faced multiple choices between (smaller) sooner and a (larger) later reward. Both price lists consisted of twelve decisions between sooner and delayed payoffs. The sooner payoffs varied between CHF 9 and CHF 20 in steps of CHF 1, whereas the delayed payoff was fixed at CHF 20. In the first price list, participants chose between an immediate payoff and a payoff in four weeks. In the second price list, students decided between a payoff in four weeks and a payoff in eight weeks.

On both price lists, we observe the minimal earlier amount at which an individual still preferred the earlier amount, as well as the maximal earlier amount at which an individual still preferred to wait for the larger later amount. We define the midpoint between these two amounts as the switch point (denoted x_{0W} for the first price list with immediate payments and x_{4W} for the second price list in which the earlier payment is in four weeks). For example, a student may have preferred to wait for CHF 20 if the earlier amount was CHF 17, but preferred the earlier amount if it was CHF 18. In this case, we would assign a switch point of CHF 17.5.[13]

Using time-dated monetary rewards to measure time preferences has advantages and disadvantages (see, e.g., Andersen *et al.*, 2008; Andreoni and Sprenger, 2012a,b; Andreoni *et al.*, 2015; and Augenblick *et al.*, 2015). First, the identification of time preferences rests on the assumption that students treat money like consumption. Second, future payments need to be credible and should not involve non-negligible transaction costs. Finally, assumptions have to be made about the curvature of the utility function, and curvature should be explicitly controlled for.

[13] This method can only be applied when students displayed a unique switch point, i.e., when their choices were consistent. More than 95% of students indeed displayed consistent choices. In the case of multiple switch points, we determined the switch point that would be 'most consistent' with the overall choice pattern. 'Most consistent' is defined as the switch point for which the actual choice pattern displays the fewest errors. Only in 15 out of 992 cases (1.5%) were we unable to at least determine a unique 'most consistent' switch point. These observations are dropped from the analysis. There is also a small number of participants who always chose the delayed payoff (around 3% of our observations). Because we do not observe the minimal earlier amount at which these students would have preferred the earlier amount, we assume indifference at the final decision and assigned a switch point of CHF 20.

Our decision to use time-dated monetary rewards and multiple price lists was driven by important constraints inherent to our field setting. In particular, access to students was restricted to school hours. Consequently, one session needed to be completed within 95 minutes, including payments. This severely constrained our ability to conduct more time intensive measures of time preferences that do not rely on timed monetary rewards,[14] and multiple price lists were the only viable alternative in our study setting. Moreover, time preference measurements based on timed monetary rewards have substantial predictive power for real-world decisions.[15] Dohmen *et al.* (2017) found no evidence that choice patterns in multiple price lists can be explained by the potential confounds mentioned above in a representative sample of adults in Germany, and Balakrishnan *et al.* (2020) showed that measures using multiple price lists and convex time budgets (Andreoni and Sprenger, 2012a) are strongly and highly correlated. We therefore believe that multiple price lists with timed monetary rewards are a useful elicitation tool, especially in environments in which more complicated and time-intensive elicitation procedures are infeasible.

We also took specific measures to address the concerns mentioned above. Regarding credibility, transaction costs and arbitrage, we explicitly guaranteed credibility of future payments by an official statement from the University of Fribourg and we had the official endorsement from the school administration. Future payments were mailed in cash to the homes of the students on the specified day, and envelopes were already inscribed by the students themselves and franked on the day of the study. Moreover, we include an explicit question on credit constraints.

To control for the curvature of the utility function, students also participated in a lottery task with real payoffs to elicit individual risk aversion. Participants made ten decisions between certain payoffs and a coin toss. The certain payoffs varied between CHF 1 and CHF 10 in steps of CHF 1. The coin toss yielded CHF 10 in the case of 'heads' and CHF 0 in the case of 'tails'. A revealed preference for a lower certain payoff over the coin toss indicates stronger risk aversion. For each student, we observe the highest certain payoff at which a student still preferred the coin toss as well as the lowest certain payoff at which a student started to prefer the certain payoff. We define the midpoint of this interval as the switch point x_R at which a student was just indifferent between the coin toss and the safe amount.[16] As a descriptive measure of risk aversion, we define $\rho = 10 - x_R$, such that higher values of ρ indicate higher risk aversion.[17]

2.2. *Identification of Preference Parameters*

We use decisions in all price lists to infer revealed time preferences as well as to structurally estimate time preferences of our study participants. To do so, we need to make assumptions on individual utility functions.

[14] For example, using real effort in the spirit of Augenblick *et al.* (2015), or measures that rely on many more individual decisions than our elicitation method (such as convex time budgets, Andreoni and Sprenger, 2012a).

[15] See, for example, Meier and Sprenger (2010; 2012), Golsteyn *et al.* (2014), Sutter *et al.* (2013), Backes-Gellner *et al.* (2018). Halevy (2014) also provided an extensive discussion and argument in favour of timed monetary rewards to measure time preferences.

[16] Again, in the case of multiple switch points, we assigned a 'most consistent switch point' whenever possible. Most (98%) students displayed consistent choices. Only in 4 out of 496 cases (< 1%) were we unable to determine at least a unique 'most consistent' switch point. These observations are dropped from the analysis.

[17] A few students (4%) always preferred the safe outcome, even when the safe outcome was only CHF 1. Since we do not observe the highest certain payoff at which a student preferred the coin toss, we assigned $x_R = 0.5$ to these cases. Moreover, two students always chose the lottery, even when the safe outcome was CHF 10. We assume indifference at the final decision and assigned $x_R = 10$ to these cases.

First, we assume that individuals' intertemporal preferences are represented by the following utility function that is additively separable in time:

$$U^t(u_t, u_{t+1}, \ldots) = \delta^t u_t(x_t) + \beta \sum_{\tau=t+1}^{\infty} \delta^\tau u_\tau(x_\tau). \tag{1}$$

Here t measures four-week intervals and $u_t(x_t)$ indicates the instantaneous utility received at time t from monetary reward x_t. Second, we need to model instantaneous utility u_t. We do so in two separate ways. In our first specification, we assume that the instantaneous utility in period t is linear in the received monetary reward, and exactly equals the monetary amount: $u_t(x_t) = x_t$. In our second specification, we model instantaneous utility assuming constant relative risk aversion, $u_t(x_t) = x_t^{1-r}/(1-r)$, where r is an individual's parameter of relative risk aversion.

The first, linear utility specification allows us to directly determine individual estimates for δ and β, using (1). To do so, we exploit the switch point in individuals' decisions between sooner and later payoffs as an indicator of an individual's point of indifference. To illustrate this, let us consider the second price list, with all payments in the future. Assuming that $u_t(x_t) = x_t$ and using (1), indifference between the switch point, x_{4W}, in four weeks and CHF 20 in eight weeks implies that $x_{4W} = \delta 20$. We hence obtain $\delta = x_{4W}/20$.[18]

Now, consider the first price list with immediate and future payments. For each student, we observe the switch point x_{0W} at which the student was indifferent to CHF 20 in four weeks. Equation (1) now implies that $x_{0W} = \beta\delta 20$. Substituting the expression for δ from above yields $\beta = x_{0W}/x_{4W}$.[19] Moreover, we create an additional variable to capture present biased individuals, a dummy variable, β^*, that takes a value of 1 for students with $\beta < 1$ and 0 otherwise.

Our first set of analyses use these constructed individual preference parameters to assess whether we can identify differences by language group in revealed time preferences.

In our second specification of instantaneous utility, we assume that individuals have constant relative risk aversion,

$$u = \frac{x^{1-r}}{1-r},$$

where higher values of r imply larger risk aversion. Such a specification allows us to explicitly account for curvature in the utility function, which can be important when making inferences about time preferences (see Andersen *et al.*, 2008; 2014b). When using this specification, we utilise the switch points in the two time preference elicitation tasks as well as in the risk aversion task to infer time preference parameters as well as the parameter of relative risk aversion. More precisely, decisions in the three price lists imply three indifference conditions.

First, the switch point in the risk elicitation task identifies the safe amount x_R at which a student is revealed indifferent between this safe amount and a 50% chance to win CHF 10. Hence, we have

$$u(x_R) = 0.5u(10), \qquad x_R^{1-r} = \frac{10^{1-r}}{2}.$$

[18] In principle, we only observe an upper and a lower bound on δ. The upper bound is implied by the minimal earlier amount at which an individual still preferred the earlier amount. The lower bound is implied by the maximal earlier amount at which an individual still preferred to wait for the larger later amount. There is therefore a potential range of δ values that is consistent with an individual's choice pattern. We chose to define the preference parameter at the midpoint of that range, and all our results are robust to alternative specifications.

[19] As above, since we only identify a range for the switch point in the price lists, the choice pattern allows for a potential range of values for β. Our results are robust to switch point choices within the identified range.

Second, the switch point in the second price list (x_{4W}) implies that

$$\delta u(x_{4W}) = \delta^2 u(20), \qquad x_{4W}^{1-r} = \delta 20^{1-r}.$$

Finally, the switch point in the first price list (x_{0W}) implies that

$$u(x_{0W}) = \beta\delta u(20), \qquad x_{0W}^{1-r} = \beta\delta 20^{1-r}.$$

We utilise these three indifference conditions to structurally estimate r, δ and β simultaneously, using the generalised method of moments (Hansen, 1982).

2.3. *The Role of Language in Shaping Time Preferences*

Our time preference measures are also informative regarding potential channels that might cause differences in preferences across language groups. For example, Chen (2013) recently proposed the hypothesis that one cause of individual differences in discounting might be language. He postulated that languages that grammatically associate the future and the present foster future-oriented behaviour in terms of savings and other economic outcomes. Indeed, Chen found initial correlational evidence consistent with such a relationship, such as higher savings rates, wealth and a healthier lifestyle. The evidence in Falk *et al.* (2018) and Sutter *et al.* (2018) also corroborate the existence of such correlations.

Chen's hypothesis is based on the so-called Sapir-Whorf hypothesis (Boas, 1940; Sapir, 1949; Whorf, 1956) that postulates that language fundamentally affects our thinking. Speaking about future events as if they were happening now leads speakers to perceive future events as less distant, which in turn manifests itself in more future-oriented behaviour. Consequently, it is hypothesised that perceptional effects triggered through the use of present and past tense in the language lead to lower discount rates. As we have pointed out in the introduction, there is scepticism regarding the validity of this hypothesis, both in terms of the Sapir-Whorf hypothesis (Roberts and Winters, 2012) and in terms of the categorisation of languages (Dahl, 2013). Ultimately, the validity of the hypothesis is an empirical question, and more empirical work is necessary to assess its validity. We can contribute to this discussion in multiple ways.

First, Chen's hypothesis has so far been tested with respect to discount rates in general, without differentiating between long-run (exponential) and short-run (present biased) discount rates. If differences in language universally cause differences in discounting, this would imply that, in our study setting, long-run discount rates of German speakers who grammatically associate the future and the present are larger than those of French speakers: $\delta_{\text{FR}} < \delta_{\text{GE}}$. This observation leads to our first hypothesis.

HYPOTHESIS 1 (EXPONENTIAL DISCOUNTING). *German speakers have higher estimated exponential discount factors, δ, than French speakers: $\delta_{\text{GE}} > \delta_{\text{FR}}$.*

We can take Chen's hypothesis a step further however and propose a refinement of Chen's linguistic savings hypothesis. The essence of the hypothesis is that the forced *change in tense* in a language causes an increase in perceived distance, and hence an increase in discounting and a decrease in future-oriented behaviour. But since such a change only occurs for comparisons between the present and the future, and not for comparisons between two future events, one can argue that behavioural differences should primarily be present for intertemporal trade-offs that actually involve the present. While an exponential discounting model is unable to capture potential differences in discount factors over identical time spans depending on their realisation relative to today, models of hyperbolic discounting are. In fact, the quasi-hyperbolic model has the exact same emphasis on the present as the linguistic savings hypothesis. Discounting between present and future events is exacerbated through β, but discounting between two future events is not, and hence less pronounced.

We therefore hypothesise that the effects of language on behaviour should in particular be visible for trade-offs that actually involve the present. Only in such instances can language actually affect the perception of distance between relevant events. Translated into preference parameters of a quasi-hyperbolic discounting model, one would therefore expect an effect of language on β.

HYPOTHESIS 2. *German speakers are less present biased (β) than French speakers: $\beta_{\mathrm{GE}} > \beta_{\mathrm{FR}}$.*

In principle, one could take the prediction one step further and hypothesise that, according to our refined hypothesis, language should *only* affect β, and not δ. However, such a hypothesis is based on very strong assumptions about the nature of the utility function over time, in particular that the β-δ model is a correct representation of preferences. Other models of hyperbolic discounting would not make the same, stark prediction, but only predict that patience increases with the time horizon.[20] The prediction that there should be no effect on δ at all can therefore only be treated as a joint test of the linguistic savings hypothesis and the β-δ model.

2.4. *Procedures*

Preferences were measured in nine sessions, conducted in April 2017 at the lower secondary school in the bilingual municipality of Murten, Switzerland. In our study 496 students aged between 12 and 17 years participated. This corresponds to 88.4% of all students. Seventy percent of participants follow the curriculum in German, and the remainder in French. Participation rates were slightly higher in the German section (91%) than in the French section of the school (83%).

The study was run with paper and pen. Upon arrival, students took their place at the desks where the questionnaires, pens and envelopes were placed. Students received instructions in their main schooling language. They were then read aloud by a trained and bilingual member of our research team.[21] Questionnaires were filled out individually and privately. The order of the tasks and questions was the same for all participants. The understanding of participants was checked using control questions.

We also administered a socio-demographic questionnaire including questions on gender, age, migration background, family structure and material conditions, parental background, schooling and cultural values. We use these measures as additional controls in our analysis.

On average, a session lasted about 95 minutes, including payment. Payment was given anonymously for one randomly chosen period from the two multiple price lists and one decision from the lottery task.[22] If the delayed payment was drawn, participants received a guarantee letter from the Department of Economics of the University of Fribourg stating the amount to be sent via mail at the specified future date. The purpose of the guarantee letters was to raise credibility

[20] For example, the often used hyperbolic discounting function $D(t) = (1 + \alpha t)^{-1}$, in which language could be modelled as having an effect on α.

[21] All sessions, German and French, were led by the same researcher and research team.

[22] At the end of the study, each participant rolled first a twenty-four-sided cube to randomly select one decision out of two multiple price lists, and then a ten-sided cube to randomly select one decision out of ten from the lottery task.

of the future payments among participants, which is particularly relevant for the first price list where students decided between immediate and delayed payoffs. All other payments were made immediately. On average, participants received CHF 25.74, CHF 19.39 in the discounting tasks and CHF 6.36 in the lottery task.[23]

Our study and the key hypothesis that German language should be correlated with higher time preference parameters (δ, β and β^*) was pre-registered at the AEA RCT registry (https://www.socialscienceregistry.org/trials/2021/history/15724). However, the paper and analyses have evolved since pre-registering. Additional empirical specifications have been added, and some pre-registered comparisons, such as between bilinguals and monolinguals, receive less attention. The key pre-registered specifications are the ordinary least squares (OLS) and probit specifications presented in Subsection 3.3 and in parts of Subsection 3.4. Some of the descriptive analyses as well as the generalised method of moments (GMM) and Lasso specifications were added after the pre-registration. For transparency, all specifications that are run as pre-registered are demarcated with an asterisk. We report two-sided p-values in all tables, but given our pre-registration and the clearly one-sided nature of the hypotheses, we often refer to one-sided p-values in the main text.

3. Results

3.1. *Descriptive Statistics*

We start our analysis by comparing choices in the two price lists across German and French language classes. Panel (a) in Figure 1 illustrates the distribution of individual choices between immediate and delayed payoffs. First, and as one would obviously expect, it can be seen that the immediate payoff is chosen more frequently as the immediate payoff becomes larger. It also appears that students in French-speaking classes are more likely than those in German-speaking classes to switch to the immediate payoffs as the immediate payoff increases. This difference is particularly pronounced for immediate payoffs between CHF 15 and 19.

Panel (b) displays the average behaviour for both language groups for all twelve decisions in the second price list, when the students faced a choice between a (weakly) smaller amount in four weeks and an amount of CHF 20 in eight weeks. As before, the majority of students prefers to wait when the immediate amount is small, but students increasingly switch to the earlier payoff as the earlier payoff gets larger. Again, French speakers appear to be less likely than German speakers to wait for a delayed payoff in eight weeks, and the difference becomes most pronounced for sooner payoffs between CHF 15 and 19.

[23] After the study was finished, we learned that, in some German classes, the teachers encouraged students to contribute the earnings from our study to the class budget, without knowing the details of our study. Obviously, this unwanted intervention made us worry about the validity of our preference measures. In particular, one might argue that this intervention could *increase* measured patience and hence distort our preference measurements. However, teachers could not enforce contributions because they did neither observe participants choices nor their earnings directly, i.e., what they earned and at what time. If asked, the dominant strategy of students would have been to simply claim to have gotten the lowest possible amount, and in fact to reveal their true preferences in the experiment. Nevertheless, the teacher intervention could potentially have influenced students decisions during the study. Fortunately, we can identify three otherwise identical pairs of German classes (parallel classes in the same grade level) in the tenth and eleventh grades with the feature that one of them was affected by such an intervention and the other one was not. This allows us to test whether student behaviour became more patient in classes with teacher intervention. The average switch point in the first price list was 18.2 without teacher intervention and 17.6 in classes with teacher intervention. The average switch point in the second price list was 18.4 without teacher intervention and 17.7 in classes with teacher intervention. We can therefore reject the null hypothesis that the intervention increased patience (one sided p-values of t-tests: $p = 0.06$ and $p = 0.10$, respectively).

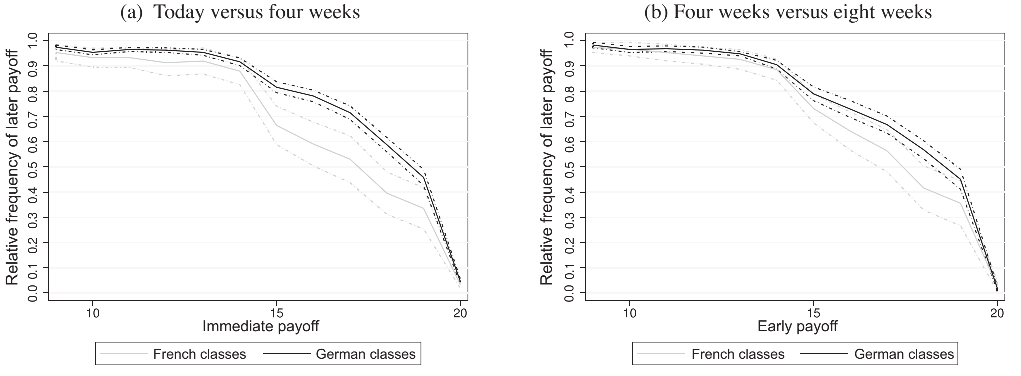

Fig. 1. *Relative Frequency of Delayed Payoff Choices by Class Language.*
Notes: Each figure includes 496 observations. Dotted lines display one SD of the mean, where SEs are clustered at the class level.

Table 1. *Relative Frequency Differences in Choosing the Earlier Payoff by Class Language.*

	Today vs. four weeks		Four weeks vs. eight weeks	
Decision	GE-FR	SE	GE-FR	SE
9 vs. 20	−0.021	0.033	−0.010	0.022
10 vs. 20	−0.021	0.038	0.001	0.028
11 vs. 20	−0.033	0.039	−0.015	0.034
12 vs. 20	−0.050	0.051	−0.023	0.034
13 vs. 20	−0.034	0.051	−0.022	0.039
14 vs. 20	−0.037	0.054	−0.020	0.044
15 vs. 20	−0.151*	0.076	−0.058	0.061
16 vs. 20	−0.190**	0.087	−0.087	0.080
17 vs. 20	−0.184*	0.093	−0.104	0.087
18 vs. 20	−0.192**	0.086	−0.152	0.091
19 vs. 20	−0.123	0.085	−0.095	0.094
20 vs. 20	−0.013	0.017	0.007	0.022

Notes: OLS regressions showing the differences in the relative frequency of choosing the earlier payoff by class language for the first price list (today versus four weeks) and the second price list (four weeks versus eight weeks). Column 'GE-FR' displays the coefficient estimate on a German dummy, showing the difference in relative frequency of the earlier choice between German- and French-speaking classes. SEs are clustered at the class level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Number of observations: 496. Number of clusters: 29. In the second price list (four weeks against eight weeks), the decisions CHF 13 versus 20, 14 versus 20, 16 versus 20, 19 versus 20 and 20 versus 20 have one missing observation ($N = 495$).

Table 1 provides further statistical support for differences in discounting between the two language groups. It reports the differences in the frequency of the early payoff choice between the two language groups by regressing the choice of the earlier payoff option on a German class language dummy for each individual choice that the students faced. The left panel of Table 1 shows the difference by class language for each decision in the first price list, which involved a choice between a varying payoff today and CHF 20 in four weeks. The left panel shows the difference by class language for each decision on the second price list, which involved a choice between a varying payoff in four weeks and CHF 20 in eight weeks.

The table reveals that there is no statistical difference between the two language groups as long as the earlier payoffs are sufficiently small. However, when the earlier payoff is in a range between CHF 15 and CHF 18, students in French-speaking classes become significantly more likely to choose the earlier payoff when the earlier payoff is paid out today. This differential behaviour is also captured by a Kolmogorov-Smirnov (KS) test for equality in distributions of switch points across language groups, which yields a p-value (henceforth p) of 0.001 (not accounting for clustering). For the second price list, in which the earlier payoff is paid out in four weeks, differences between the two language groups are less pronounced. Even though this entails a reduction of the statistical significance of differences for specific decisions (for the largest difference at CHF 18 versus 20, the cluster-robust p-value of a one-sided t-test is marginally significant with a p-value of 0.054),[24] the KS test on the distribution of switch points still yields a p-value of 0.016 (again not accounting for clustering), thus pointing to differences in the distributions across language groups.

RESULT 1. *Students in German-speaking classes display more patient behaviour than students in French-speaking classes.*

3.2. *Analysis of Switch Points*

So far, we have focused on the twenty-four binary decisions between earlier and later amounts, but have ignored other factors that might affect time preferences. Despite our setting at the language border in which students share the institutional and socio-economic environment, it could be that they nonetheless differ in important dimensions that in turn affect their time preferences. To rule out that our observed differences in discounting are driven by such omitted factors, we now turn to multivariate regression analyses.

First, we investigate the effects of language on students' switch points in the two price lists, using tobit regressions. For each student, the most consistent switch point is used as an observation for each price list, implying that the regression includes two observations per student: the switch point in price list 1 and the switch point in price list 2.[25] Moreover, a few students never switch. They either always prefer the earlier or always prefer the later amount.[26] Consequently, their true switch point is either censored above or below, due to our experimental elicitation procedure. To account for this censoring, we use tobit regressions and focus on the estimated latent switch point in our regression interpretations.

Table 2 provides the results of these estimations. The first regression model (column (1)) only includes a dummy for German class students (German), a dummy for the delayed price list (four weeks) and an interaction term of these two dummies. The second specification (column (2)) additionally controls for risk aversion. In our third specification (column (3)), we further add an array of important socio-demographic background characteristics that were identified by the literature as potentially being related to intertemporal preferences (see, for example, Dohmen

[24] Table A1 in the Appendix reports similar regression results with heteroscedasticity robust SEs instead of clustered SEs. It is not clear whether clustering at the class level is truly warranted in this individual decision-making task. Without clustering, differences in the second price list become significant as well.

[25] In 15 out of 992 cases (1.5%), we could not determine a most consistent switch point. These observations are dropped.

[26] We found that 2.3% of students switch at the smallest amount in the early price list and 1.6% of students switch at the smallest amount in the delayed price list; 3.6% of students always choose the delayed amount in the early price list and 2.3% of students always choose the delayed amount in the delayed price list. Using OLS instead of tobit specifications does not substantially alter any of our results.

Table 2. *Tobit Regressions on Switch Points.*

	(1)	(2)	(3)
German	1.131***	1.102***	1.272***
	(0.287)	(0.289)	(0.308)
Four weeks	0.265	0.271	0.437*
	(0.225)	(0.226)	(0.239)
German × four weeks	−0.502**	−0.514**	−0.623**
	(0.255)	(0.257)	(0.273)
Constant	16.620***	16.236***	22.298***
	(0.252)	(0.397)	(4.066)
Controls	None	Risk	All
Pseudo R^2	0.01	0.01	0.03
Observations	977	969	824

Notes: Tobit regressions on individual most consistent switch points. Two observations per individual are included (one for each price list), except in cases in which no most consistent switch point could be determined (1.5% of the cases). SEs are clustered at the individual level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Results for the full specification of columns (2) and (3) are reported in Table A3 in the Appendix. Regression results with SEs clustered at the class level are reported in Table A2 in the Appendix.

et al., 2010; Backes-Gellner *et al.*, 2018; Brown *et al.*, 2018; Sutter *et al.*, 2018). These include age, gender, Swiss citizenship, how trusting the participant is (measured using the trust question from the World Preference Survey, Falk *et al.*, 2018), the number of siblings in the family and parents' ages. We also add dummies for the class grade (9, 10 or 11) as well as for the school track (A, B, C or E). We used several proxies for household income, such as the housing conditions (the type of housing and the availability of an own room) and weeks of holidays spent in the previous year. To control for liquidity constraints that might drive students' intertemporal choices, we asked students to assess the difficulty they have to raise CHF 100 on a five-point Likert scale (the higher the number indicated the smaller the difficulty) along with their pocket money per week in CHF. Finally, we add a dummy for correctly answering comprehension questions during the experiment, and some proxies of personality traits: whether respondents claimed to be encouraged by their parents to be independent, responsible, hardworking, unselfish and religious.[27]

Column (1) in Table 2 provides estimation results for our most basic specification without any further controls. Students in French-speaking classes on average switch to the early payment in the early price list when they are offered CHF 16.62 today. Students in German classes additionally require 1.13 before they switch, and this difference is highly significant. When all payments are delayed, French-speaking students become slightly more patient, but the effect is not statistically significant. However, the interaction between the German class dummy and the delayed price list is negative and significant. It implies that students in German-speaking classes only require CHF 0.63 more than students from French-speaking classes before they switch to the earlier payoff in the second price list, which is still a statistically significant effect ($p < 0.03$). The decrease in the difference between the two language groups of CHF 0.50 is also statistically significant.

[27] In Table A6 in the Appendix, we present and compare our socio-demographic controls across language groups. German speakers on average have a higher socio-economic status, proxied by home ownership. Parents of German-speaking students are older, and the German community is composed of fewer foreigners. Hence, these variables constitute important controls when assessing differences in time preferences across language groups.

Table 3. *Mean Values of Time Preference and Risk Preference Parameter Estimates by Class Language.*

	FR	GE	GE-FR	p-value (robust)	p-value (clustered)	N
δ	0.843	0.875	0.031	0.020	0.246	492
	(0.139)	(0.127)	(0.027)			
β	0.998	1.023	0.025	0.123	0.187	481
	(0.172)	(0.146)	(0.019)			
β^*	0.306	0.201	−0.106	0.017	0.048	481
	(0.462)	(0.401)	(0.053)			
ρ	4.541	4.988	0.448	0.015	0.050	492
	(1.814)	(1.979)	(0.228)			

Notes: Most consistent choices are used as outcome variables. 'FR' and 'GE' stand for French and German, respectively. 'p-value (robust)' provides p-values of two-sided mean difference t-tests of German versus French ('GE-FR') using heteroscedasticity robust SEs without clustering. 'p-value (clustered)' gives the respective p-values when clustering at the class level. Values in parentheses are SDs in the case of 'FR' and 'GE' and clustered SEs in the case of the difference 'GE-FR'. Here N gives the sample size. Table A4 in the Appendix presents mean values of time preference parameter estimates by class language for consistent choices only.

When additional controls are included in the regression specification (columns (2) and (3)), the basic patterns from our simplest specification are confirmed. Controlling for important socio-economic characteristics, we find that students in French-speaking classes become marginally significantly more patient when all payments are delayed. Moreover, the decrease in the difference in patience between German and French class students is robust to controls and remains significant.[28]

Taken together, the reduced-form analyses in Subsections 3.1 and 3.2 provide strong evidence that students in French-speaking classes display less patience than students in German-speaking classes when immediate payments are involved, but the difference is reduced when all payments are delayed.

RESULT 2. *The difference in revealed patience between students from German- and French-speaking classes is significantly reduced when intertemporal trade-offs only involve future payments.*

3.3. *Analysis of Individual Preference Parameters*

A main feature of our study design is that it also enables us to uncover individual preference parameters. As outlined in Subsection 2.2, assuming that individuals' intertemporal preferences are represented by (1), and that instantaneous utility is linear in money, i.e., $u(x_t) = x_t$, we can infer preference parameters for every student directly from their choice patterns. We now use these inferred parameters to directly assess the relationship between language and preference parameters.

Table 3 presents the mean values of these time preference parameter estimates by class language.[29] The average switch point in French-speaking classes in the second price list (only

[28] In Table A2 in the Appendix, we report results for the same tobit specifications with SEs more conservatively clustered at the class level. The coefficients on the German dummy remain significant at the 10% level in all specifications. The interaction of the German dummy with the delayed price list only remains at least marginally significant when applying one-sided tests.

[29] As explained in Section 2.2, we use the most consistent unique switch point to determine these values. Table A4 in the Appendix reports the same statistics using only consistent answers. The conclusions remain unchanged.

concerning future payoffs) was CHF 16.9, which translates into a discount factor of $\delta_{FR} = 0.84$, whereas the average switch point in German classes was CHF 17.5, which translates into a discount factor of $\delta_{GE} = 0.88$. The difference in discount factors is significant without clustering, but significance is weak once SEs are clustered at the class level ($p = 0.123$ in a one-sided test).

When comparing average estimates of β, we find that French-speaking students have a lower β compared to German-speaking students, and the difference is marginally significant ($p = 0.094$, one-sided t-test with clustered SEs).[30] A striking difference across the two language groups appears when comparing the fraction of the respective population that displays some present biasedness. We define a student as present biased if the student displays stronger discounting on the first price list (involving immediate payments) compared to the second (involving only future payments). Here β^* is defined as a dummy variable that is equal to one in case a student is present biased in such a manner. The third line in Table 3 reveals that 31% of students in French-speaking classes display present biasedness, whereas only 20% of students in German classes do. This 11 percentage point difference is statistically significant ($p = 0.024$, one-sided t-test with clustered SEs).

Finally, the last line in Table 3 shows that students in French-speaking classes are significantly less risk averse than students in German-speaking classes. Whereas students in German-speaking classes are on average risk neutral, students from French-speaking classes even show slight risk lovingness with an average switch point of 5.5.[31]

Given that students differ in risk preferences, and hence in the curvature of the utility function, controlling for risk preferences will be important for making inferences about differences in time preferences. We apply three regression approaches to assess the impact of language on time preference parameters. First, we use individual preference parameters, based on the assumption that utility is linear in money, and regress them on our set of controls using OLS. Second, we apply lasso estimations to select control variables in a data-driven way. Finally, we use GMM to simultaneously estimate time and risk preference parameters, explicitly allowing for curvature in the utility function.

For the OLS regressions, the effects of class language on students' time preference parameters are estimated using the specification

$$Y = \alpha_0 + 1_{\{\text{German}\}}\alpha_1 + \mathbf{X}'\alpha_2 + U,$$

where Y is the outcome of interest, i.e., individual preference parameters δ and β, or a dummy variable that indicates some degree of present bias β^*, $1_{\{\text{German}\}}$ is an indicator that takes value one for German being a schooling language and zero otherwise, $\mathbf{X}'$ is a vector of the control variables defined in Subsection 3.2 and U is the error term. In order to account for potential dependencies among students studying in the same class, we cluster SEs at the class level.

In our first regression model, we only add individual risk preferences as a control, as well as a dummy for missing risk aversion. In our second specification, we add the set of control variables specified in Subsection 3.2. Detailed results for all regressors of this specification are presented in Table A7 in the Appendix. While in these two specifications, δ and β are estimated by OLS,

[30] It also appears that, on average, neither the German class students nor the French class students are particularly present biased in our study. But there is considerable heterogeneity across students, some displaying considerable present bias, while others have moderate future bias. Overall, 23% of the students display present bias, 28% display future bias and 49% are time consistent. Meier and Sprenger (2012) found comparable degrees of future bias in their data.

[31] Remember that ρ is coded as $10 - x_R$.

Table 4. *Effects of Class Language across Specifications.*

	(A) OLS/probit*		(B) Lasso	(C) GMM	
	(1) Risk	(2) Controls	(3)	(4) No controls	(5) Controls
δ estimate					
German class dummy	0.031	0.038	0.042	0.062	0.049
SE	0.027	0.018	0.030	0.033	0.022
Two-sided p-value	0.248	0.035	0.169	0.062	0.028
One-sided p-value	0.124	0.018	0.085	0.031	0.014
Observations	488	415	476		
β estimate					
German class dummy	0.021	0.020	0.022	0.031	0.030
SE	0.018	0.013	0.026	0.022	0.015
Two-sided p-value	0.233	0.114	0.405	0.156	0.045
One-sided p-value	0.116	0.057	0.203	0.078	0.023
Observations	477	407	466		
β^* estimate					
German class dummy	−0.098	−0.099	−0.118		
SE	0.051	0.063	0.066		
Two-sided p-value	0.054	0.119	0.082		
One-sided p-value	0.027	0.059	0.041		
Observations	477	407	493		
r estimate					
German class dummy				0.199	0.152
SE				0.071	0.051
Two-sided p-value				0.005	0.003
One-sided p-value				0.003	0.002
Observations (GMM)				477	475

Notes: Sample contains observations with mostly consistent choices and non-missing values in the respective outcome, language dummy and control variables. Coefficient estimates for all control variables in specification (2) are presented in Table A7 in the Appendix. Table A8 in the Appendix shows estimation results when using consistent choices only. Table A9 in the Appendix shows estimation results for the OLS specifications when restricting both specifications to the same number of observations. The estimated coefficients for β^* in panel (A) correspond to the average marginal probit effects. The asterisk for panel (A) denotes that those regression specifications were pre-registered. SEs are clustered at the class level in all specifications.

we note that the estimated effects on β^* correspond to the average marginal probit effects to account for the binary nature of the outcome.

Column (A) of Table 4 shows the estimated coefficients on the German-speaking class indicator dummy. The top panel focuses on the estimated effect on δ. When controlling for socio-economic variables in column (2), students in German-speaking classes reveal a discount factor that is 3.8 percentage points larger than that of students in French-speaking classes, which is a sizeable and statistically significant difference.[32]

The middle and bottom panels in column (A) display estimated effects on β and β^*. It can be seen that the effects of class language on present bias are also pronounced and marginally statistically significant, at least once important socio-economic controls are included in the regression specification. Column (2) shows that being in a French-speaking class reduces β by 2 percentage points. When looking at the overall incidence of present bias, the bottom panel shows that students in French-speaking classes are almost 10 percentage points more likely to

[32] Table A9 in the Appendix shows regression results for column (1) when restricting the sample to the same observations as column (2). It can be seen that the difference in estimates between columns (1) and (2) is indeed driven by the inclusion of controls, and not by the change in the sample.

be present biased than those in German-speaking classes.[33] This also holds when accounting for multiple hypothesis testing by controlling the false discovery rate based on the Benjamini and Hochberg (1995) method. The latter yields a one-sided p-value of 0.059 for the estimated effects on both β and β^*.

Because we have collected many potential control variables, we next select from the full set as well as several higher-order and interaction terms[34] those controls that importantly predict either the linguistic treatment or the outcome (or both) in a data-driven way by applying the so-called 'post-double-selection' method (see, for instance, Belloni *et al.*, 2014 and Chernozhukov *et al.*, 2015). This ensures that control variables that are non-negligibly related to both the treatment and the outcome are accounted for. The method consists of two steps for control variable selection and treatment effect estimation. In the first step, a linear lasso regression is applied separately for predicting the linguistic treatment and the outcome based on the control variables.[35] In the second step, the outcome (i.e., δ, β or β^*) is regressed on the treatment and all of the lasso-selected control variables of the first step using standard OLS, which is known as 'post-lasso' estimation.[36] Observations with missing values in any of the potential control variables are excluded for the first step. In the second step, we only exclude observations with missing variables in any of the selected control variables. As before, SEs are clustered at the class level.[37]

The results are displayed in panel (B) in Table 4. The effect of the German class language dummy on δ is similar in magnitude to the OLS estimates and remains significant at the 10% level (one-sided test). The coefficient estimates for the effects on β and β^* are also comparable in magnitude. The effect on the incidence of present bias (β^*) remains statistically significant at the 5% level (one-sided test).

Finally, we use a GMM approach (Hansen, 1982) to simultaneously estimate time preferences and curvature of the utility function. As described in Subsection 2.2, we assume constant relative risk aversion and exploit decisions in the three multiple price lists to derive three indifference conditions. The latter serve as moment conditions for identifying the preference parameters in a just identified GMM framework. To improve the computational properties of the estimator, we take the log of each moment condition such that the risk aversion parameter is not in the power of the mathematical expression. We therefore use the following three moment conditions to jointly estimate the three preference parameters r, δ and β:

$$(1-r)\ln(x_R) = (1-r)\ln(10) - \ln(2),$$

$$(1-r)\ln(x_{4W}) = \ln(\delta) + (1-r)\ln(20),$$

$$(1-r)\ln(x_{0W}) = \ln(\beta) + \ln(\delta) + (1-r)\ln(20).$$

[33] Table A7 in the Appendix shows that higher risk aversion is predictive in particular of lower present bias. Moreover, Swiss nationality is predictive of higher patience. In addition, students who indicate that their parents encourage responsible behaviour are also more patient. Finally, trust is significantly correlated with both δ and β estimates.

[34] This includes the square and cube of age, number of siblings squared, as well as gender interacted with age, number of siblings, pocket money per week and being born in Switzerland, respectively.

[35] In contrast to OLS, lasso selects variables by setting the coefficients of less important predictors to zero, based on a penalty term that restricts the sum of absolute values of slope coefficients in the model.

[36] The lasso coefficients do not generally correspond to the OLS coefficients obtained in the 'post-lasso' step even when both procedures rely on the selected predictors only. The reason is that, even among selected predictors, lasso may shrink some coefficients towards zero (relative to OLS) to obey the penalisation.

[37] We implement the post-double-selection method using the 'pdslasso' command for the statistical software 'Stata' by Ahrens *et al.* (2018).

To estimate the effect of class language on these preference parameters, we further specify the preference parameters as a linear function of the class language dummy and the covariates, similar to our OLS specifications before, i.e.,

$$y = \alpha_{y0} + 1_{\{\text{German}\}}\alpha_{y1} + \mathbf{X}'\alpha_{y2},$$

where y is the respective preference parameter of interest (i.e., r, β or δ). SEs are again clustered at the class level.

Column (C) of Table 4 provides the GMM results, once only including the German class dummy as an explanatory variable of the preference parameters, and once controlling for important additional controls.[38] The bottom-right panel shows that students in German-speaking classes are significantly more risk averse than students in French-speaking classes, consistent with the descriptive evidence from switch points in Table 3. Moreover, students in German-speaking classes have significantly higher δ, and explicitly controlling for the curvature of the utility function also leads to differences in the β estimates. When controls are added to the estimation in column (5), the differences in preference parameters become significant at the 5% level. Consequently, the joint GMM-based estimation of preference parameters corroborate our previous results. We summarise the evidence in the following result.

RESULT 3. *Estimated preference parameters show significant differences in long-run discount factors (δ). Moreover, students in French-speaking classes are significantly more likely to be present biased (β), and present bias is on average more pronounced.*

3.4. *Towards a Better Understanding of Mechanisms*

Our results indicate clear differences in both long-run discounting (δ) and present bias (β) across language groups. In the following, we attempt to shed light on potential causes of these observed differences. In Subsection 2.3, we discussed the theory proposed by Chen (2013) that language itself, through its differential grammatical association of the present and the future, may be causing behavioural differences. At the end of Subsection 2.3, we discussed a particularly stark prediction of this theory when combined with quasi-hyperbolic discounting: the difference between language groups should only be present when immediate payments are involved, but not when all payments are in the future.

Our previous results already refute this stark prediction. We do find significant differences in patience across language groups also in the second price list, and hence in the δ estimates across language groups. Our joint preference parameter estimates using GMM allow us to also test the hypothesis that language at least has a stronger effect on β than on δ. A Wald test of equivalence between the coefficient estimate of the effect of the German class dummy on δ and the coefficient estimate of the effect of the German class dummy on β reveals no significant differences ($p = 0.34$ in column (4), $p = 0.41$ in column (5)). Hence, we cannot reject the fact that the impact on both preference parameters is equal. While one may be tempted to interpret this finding as evidence against Chen's hypothesis, one has to keep in mind that this test strongly

[38] Note that in these GMM estimations, we do not use the same extensive set of controls as in the OLS regressions in column (A). Due to simultaneously estimating three different preference parameters, including additional regressors more quickly reduces the degrees of freedom and eventually causes convergence problems for the GMM estimator, in particular if they explain relatively little of the outcome variation. We therefore only include control variables with significant explanatory power for individual time and risk preferences: class dummies, track dummies, gender and Swiss nationality.

depends on quasi-hyperbolic discounting being a correct representation of preferences. As we discussed in Subsection 2.3, hyperbolic discounting models would not make the stark prediction that there should be no differences across language groups in δ, but only that there is an association with β.

A deeper question with respect to Chen's linguistic savings hypothesis is whether language inherently changes time preferences through yearlong nurture and exposure (which makes it part of—and indistinguishable from other—impacts of culture), or whether language cues at the moment of decision making are responsible for the behavioural differences. The former hypothesis would suggest that behavioural differences between language groups are inherently linked to native language, and are independent of the class language. The latter hypothesis would imply that the class language itself is the primary cause of behavioural differences. In our sample, class language is strongly and highly significantly correlated with native language ($\rho = 0.58$ for German-speaking classes and German native language, $\rho = 0.61$ for French-speaking classes and French native language), but nonetheless not every student in a German class is a native German speaker, and vice versa. The results presented in the previous section are hence consistent with both mechanisms.

Can we find corroborative evidence for either of these mechanisms? If the first mechanism is correct, the true association in the data should be between time preferences and native language, and not class language. Because of the high correlation between native language and class language, the results reported in Table 4 would partially pick up the true effect of native language, but suffer from attenuation bias. In turn, a regression on native language should produce stronger associations in the data.[39] To test this prediction, we focus exclusively on native German speakers and native French speakers. Moreover, the hypothesis is difficult to apply to students who identify as bilingual. Hence, we distinguish between those students who mention either German or French (but not both) as their native language and consider students who are both German and French bilingual as a separate, third group.[40]

Table 5 shows the respective average time preference parameter estimates for native German speakers, native French speakers and bilinguals.[41] We can see that native French speakers appear to be less patient and more present biased, but differences are smaller and statistically insignificant. Only the 9 percentage point difference in the incidence of present bias is marginally significant in a one-sided test ($p = 0.07$, with clustered SEs). Moreover, native French speakers are again significantly less risk averse than native German speakers. Finally, it can also be seen that parameter estimates for bilinguals are very similar to the estimates for native German speakers, except for the risk aversion parameter, which is similar to that of native French speakers.[42]

[39] One might think that we could simultaneously control for native language and class language in a regression design. This would be true if selection into classes were as good as random conditional on language, but this is not the case. In particular, native French speakers selecting into German-speaking classes and native German speakers selecting into French-speaking classes are clearly selected samples.

[40] Only thirty-seven students in our sample explicitly state that both French and German are their native languages. However, students might put a very high bar on declaring both languages as native, even if they are fully proficient in both languages. For this reason, we treat all students living in bilingual households and families as proficient in either language. This implies that a student is counted as bilingual if (i) both German and French are self-declared native languages (thirty-seven observations); (ii) both German and French are among the native languages of the parents (seventy-four additional observations); (iii) both German and French are spoken at home (twenty-four additional observations).

[41] We again use the most consistent unique switch point to determine these values. Table A5 in the Appendix reports the same statistics using only consistent answers. The conclusions remain unchanged.

[42] In terms of statistical significance, we find that bilinguals are significantly less risk averse than native German speakers ($p < 0.01$, one-sided t-test), and marginally significantly less likely to be present biased than native French speakers ($p = 0.06$, one-sided t-test). All other differences are insignificant.

Table 5. *Mean Values of Outcomes by Native Language.*

	FR	GE	Bi	GE-FR	p-value (robust)	p-value (clustered)	N
δ	0.865	0.878	0.873	0.014	0.424	0.536	437
	(0.127)	(0.130)	(0.117)	(0.022)			
β	0.995	1.020	1.010	0.025	0.267	0.278	428
	(0.170)	(0.157)	(0.138)	(0.023)			
β^*	0.311	0.216	0.213	−0.095	0.121	0.139	428
	(0.466)	(0.412)	(0.411)	(0.064)			
ρ	4.500	5.150	4.636	0.650	0.010	0.020	436
	(1.813)	(1.990)	(1.877)	(0.279)			

Notes: Most consistent choices used as outcome variables. 'FR', 'GE' and 'Bi' stand for exclusively French, exclusively German and bilingual, respectively. 'p-value (robust)' provides p-values of two-sided mean difference t-tests of German versus French ('GE-FR') using heteroscedasticity robust SEs without clustering. 'p-value (clustered)' gives the respective p-values when clustering at the class level. Values in parentheses are SDs in the case of 'FR', 'GE' and 'Bi' and clustered SEs in the case of the difference 'GE-FR'. Table A5 in the Appendix presents mean values of time preference parameter estimates by native language for consistent choices only.

As we have argued before, it is important to include socio-economic controls as well as to explicitly control for the curvature of the utility function to get better estimates of time preference parameters. To this end, we again apply (A) OLS and (B) GMM estimations to assess the impact of native language on time preference parameters. The sample consists of native German and native French speakers, excluding bilingual students.[43] All coefficient estimates are displayed in Table 6.

The left panel (A) provides the coefficient estimates of OLS regressions for δ, β and β^* on the German native language dummy.[44] It can be seen that estimated differences between language groups become smaller and statistically insignificant. Only the negative effect of German native language on the likelihood to be present biased remains similar in size, but also exceeds the 10% level of significance even when considering a one-sided hypothesis test.[45]

Panel (B) of Table 6 displays the results of joint estimates of the three preference parameters (δ, β and r) using GMM. Explicitly accounting for the curvature in the utility function again strengthens our results on the relationship between language and time preference parameters. Once controls are added to the regression specification, we find a marginally significant positive association between the German language dummy and δ, as well as a significant positive association with β (one-sided tests). Consistent with our descriptive statistics presented in Table 5, the results on the estimates on r show that German native speakers are significantly more risk averse than French speakers.

Our data therefore do not show that the correlation between native language and time preference parameters is more pronounced than the correlation between class language and time preference parameters, and statistical support for a significant relationship between native language and time preferences is weaker. Our data therefore do not lend strong support to the hypothesis

[43] Because of the already reduced sample size, we no longer apply the lasso, as such machine learning approaches perform poorly on small samples.

[44] Table A10 in the Appendix shows regression results for column (A) when the sample is restricted to the same set of observations in both columns (1) and (2).

[45] We also pre-registered a regression-based comparison between bilinguals as well as German and French native speakers, respectively. We find that bilinguals do not statistically significantly differ from native German or French speakers in terms of δ and β, but statistical power is low. However, bilinguals have a lower estimate of β^* than native French speakers, which is similar to that of native German speakers.

Table 6. *Effects of Native Language excluding Bilinguals.*

	(A) OLS/probit*		(B) GMM	
	(1) Risk	(2) Controls	(3) No controls	(4) Controls
***δ* estimate**				
German language dummy	0.011	0.019	0.043	0.025
SE	0.022	0.020	0.030	0.018
Two-sided p-value	0.598	0.333	0.150	0.167
One-sided p-value	0.299	0.166	0.075	0.084
Observations	301	260		
***β* estimate**				
German language dummy	0.019	0.013	0.027	0.023
SE	0.022	0.012	0.022	0.136
Two-sided p-value	0.387	0.272	0.234	0.090
One-sided p-value	0.194	0.136	0.117	0.045
Observations	298	257		
***β** estimate**				
German language dummy	−0.079	−0.096		
SE	0.062	0.078		
Two-sided p-value	0.201	0.217		
One-sided p-value	0.101	0.109		
Observations	298	257		
***r* estimate**				
German language dummy			0.230	0.182
SE			0.100	0.083
Two-sided p-value			0.022	0.028
One-sided p-value			0.011	0.014
Observations			298	298

Notes: Sample contains observations with German and/or French native languages, excluding bilinguals, mostly consistent choices and non-missing values in the respective outcome, language dummies and control variables. Same control variables as in the 'Controls' column of Table 4. Table A10 in the Appendix shows OLS results when restricting both specifications to the same number of observations. The estimated coefficient for β^* corresponds to the average marginal probit effect. The asterisk for column (A) denotes that those regression specifications were pre-registered. SEs are clustered at the class level in all specifications.

that differences in time preferences between language groups in our setting are caused by long exposure to speaking a specific language.

Can we find evidence in support of the theory that language cues at the moment of decision making are associated with differences in time preferences? To shed more light on this mechanism, we explicitly focus on our sample of bilingual students. Students that identify as bilingual have been historically exposed to both languages. Under the assumption that bilinguals do not select into French- or German-speaking classes as a function of unobservables that are correlated with time preferences, study language (which corresponds to class language) may be interpreted as a perceptual treatment at the moment of decision making.[46] If we find significant differences among this subsample by class language, it would lend some support to the hypothesis that language generates behavioural differences due to perception at the moment of decision making.

Table 7 reports results for OLS and GMM estimations.[47] The results again point to significant differences in time preferences. Column (A) shows that OLS regressions without any controls

[46] As bilingual students are not randomly allocated into classes with German and French as schooling language and differ in observed characteristics like home ownership and some of the cultural values, we cannot fully rule out that selection on unobservables occurs, even though our control variables arguably mitigate this issue.

[47] Swiss nationality is dropped as a control variable in column (5) since only four bilingual students were not of Swiss nationality, such that inclusion leads to failed convergence of the estimator.

Table 7. *Effects of Class Language, Bilingual Students.*

	(A) OLS/probit		(B) GMM	
	(1) Risk	(2) Controls	(3) No controls	(4) Controls
δ estimate				
German class dummy	0.025	0.023	0.048	0.054
SE	0.021	0.022	0.030	0.026
Two-sided p-value	0.230	0.301	0.115	0.038
One-sided p-value	0.115	0.151	0.058	0.019
Observations	134	114		
β estimate				
German class dummy	0.025	0.072	0.044	0.047
SE	0.025	0.028	0.030	0.026
Two-sided p-value	0.320	0.010	0.145	0.068
One-sided p-value	0.160	0.005	0.073	0.034
Observations	128	111		
β^* estimate				
German class dummy	−0.188	−0.219		
SE	0.081	0.101		
Two-sided p-value	0.020	0.030		
One-sided p-value	0.010	0.015		
Observations	128	111		
r estimate				
German class dummy			0.197	0.227
SE			0.098	0.085
Two-sided p-value			0.045	0.008
One-sided p-value			0.023	0.004
Observations			128	128

Notes: Sample contains bilingual observations with mostly consistent choices and non-missing values in the respective outcome, language dummies and control variables. Same control variables as in the 'Controls' column of Table 4. The estimated coefficient for β^* corresponds to the average marginal probit effect. SEs are clustered at the class level in all specifications.

only reveal significant differences in the prevalence of present biasedness among the French and German classes. Bilinguals in French-speaking classes are roughly 20% more likely to show present bias in our study. However, once controlling for socio-economic characteristics in column (2), the difference in present biasedness becomes significant, even when accounting for multiple hypothesis testing by the Benjamini and Hochberg (1995) method, yielding one-sided p-values of 0.010 and 0.015 for β and β^*, respectively.

When structurally estimating preference parameters in column (B), we again see more pronounced differences based on class language. The bottom-right panel again shows a significant difference in risk aversion. Bilingual students in German-speaking classes are significantly more risk averse than those in French-speaking classes. Moreover, even without controls, we find that bilinguals in German language classes have significantly larger δ and β estimates. Adding additional controls leaves the parameter estimate basically unaltered, but improves precision.

Table 7 therefore provides evidence in favour of a correlation between behaviour and language cues. Bilingual students in German-speaking classes (who therefore were exposed to the study in German) have significantly higher estimates of β, and a significantly lower likelihood of being present biased. They also have significantly higher estimates of δ, at least in the GMM estimations.

4. Conclusion

In this paper, we study whether time preferences differ across language groups. We focus on a specific setting at the Swiss language border where institutions are shared and socio-economic conditions are very similar across language groups. Our results show that students in French language classes in general discount more strongly than students in German language classes. Differences are particularly pronounced when immediate payments are involved, i.e., for trade-offs between present and future payments. When only future payments are involved, differences become smaller, but remain significant. Consistent with these findings, when estimating structural preference parameters for a quasi-hyperbolic discounting model, we find that students in French language classes have significantly smaller δ values, are significantly more likely to display present bias and are on average more present biased than students in German language classes. Our data therefore suggest that language groups indeed differ in their future orientation, and the effects are particularly pronounced in trade-offs that involve immediate rewards, reflecting a stronger present bias.

Our data also inform the debate about the origins of such behavioural differences across language groups. Because our language groups differ in their grammatical association of the present and the future, we can assess whether our findings are consistent with the hypothesis of Chen (2013) that language itself may have an effect on time discounting. Consistent with his hypothesis, we in particular find that differences in discounting between language groups are more pronounced when present payments are involved. In addition, we find that behavioural differences are less pronounced when comparing students by native language rather than class language, which appears contrary to the view that long-run exposure to a certain language and language-specific culture causes differences in deeply held preferences in our setting. The fact that we do find significant differences in discounting behaviour for bilingual students, conditional on class language, rather supports the view that language cues are responsible for behavioural differences, which is also consistent with the initial argument of Chen (2013) that language changes the perception of distance.

Our results contribute to the understanding and provide a potential microfoundation of observed behavioural differences between language groups, such as the lengths of unemployment spells (Eugster *et al.*, 2017) or the propensity to enter entrepreneurship (Erhardt and Haenni, 2018). Further exploring the extent to which observed differences in economic behaviours across language and culture groups may be explained by differences in underlying preferences is a fruitful area for future research.

Finally, an interesting observation is that in recent work by Chen *et al.* (2019), no difference was found when future time references were exogenously varied and time preferences were measured in an experiment with Chinese subjects. These results seem inconsistent with our finding that language cues are associated with differences in behaviour among the bilingual subsample. An important difference between the studies is, of course, that in the Chinese setting the language itself was held constant, and hence cultural cues associated with language were held constant. One interpretation could be that our result is primarily driven by cultural cues inherent in the language used, and not by the grammatical association of the present and the future. Ultimately, more data and more controlled experiments are needed in which future time reference as well as cultural cues are systematically and exogenously varied to answer this question.

Appendix A: Additional Tables

Table A1. *Relative Frequency Differences in Choosing the Earlier Payoff by Class Language.*

	Today vs. four weeks		Four weeks vs. eight weeks	
Decision	GE-FR	SE	GE-FR	SE
9 vs. 20	−0.021	0.019	−0.010	0.015
10 vs. 20	−0.021	0.023	0.001	0.018
11 vs. 20	−0.033	0.023	−0.015	0.020
12 vs. 20	−0.05	0.025*	−0.023	0.022
13 vs. 20	−0.034	0.025	−0.022	0.025
14 vs. 20	−0.037	0.031	−0.020	0.031
15 vs. 20	−0.151	0.044***	−0.058	0.042
16 vs. 20	−0.190	0.046***	−0.087	0.046*
17 vs. 20	−0.184	0.048***	−0.104	0.048**
18 vs. 20	−0.192	0.048***	−0.152	0.048***
19 vs. 20	−0.123	0.047**	−0.095	0.048**
20 vs. 20	−0.013	0.019	0.007	0.015

Notes: OLS regressions showing the differences in the relative frequency of choosing the earlier payoff by class language for the first price list (today versus four weeks) and the second price list (four weeks versus eight weeks). Column 'GE-FR' displays the coefficient estimates on a German class language dummy, showing the difference in the relative frequency of the earlier choice between German- and French-speaking classes. Heteroscedasticity robust SEs. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Number of observations: 496. Table 1 reports similar regression results with clustered SEs.

Table A2. *Tobit Regressions on Switch Points with Clustered SEs.*

	(1)	(2)	(3)
German	1.131*	1.102	1.272***
	(0.676)	(0.672)	(0.473)
Four weeks	0.265	0.271	0.437
	(0.340)	(0.341)	(0.325)
German × four weeks	−0.502	−0.514	−0.623*
	(0.362)	(0.364)	(0.351)
Constant	16.620***	16.236***	22.298***
	(0.660)	(0.801)	(4.697)
Pseudo R^2	0.01	0.01	0.03
Observations	977	969	824

Notes: Tobit regressions on individual most consistent switch points, similar to the specifications reported in Table 2. SEs are clustered at the class level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. *Tobit Regressions on Switch Points: Full Estimation Results.*

	(1)	(2)	(3)
German	1.131***	1.102***	1.272***
	(0.287)	(0.289)	(0.308)
Four weeks	0.265	0.271	0.437*
	(0.225)	(0.226)	(0.239)
German × four weeks	−0.502**	−0.514**	−0.623**
	(0.255)	(0.257)	(0.273)
Risk aversion		0.081	−0.010
		(0.067)	(0.077)
Female			0.098
			(0.236)
Age			−0.039*
			(0.022)
Swiss			0.892**
			(0.384)
Number of siblings			−0.019
			(0.125)
Mother's age			−0.008
			(0.030)
Father's age			0.014
			(0.027)
Encouraged by parents: independence			−0.261
			(0.362)
Encouraged by parents: responsible behaviour			0.631**
			(0.269)
Encouraged by parents: hard work			0.060
			(0.259)
Encouraged by parents: unselfishness			0.098
			(0.264)
Encouraged by parents: religiousness			0.739*
			(0.408)
Lives in rented house			0.839
			(0.577)
Lives in rented flat			0.202
			(0.530)
Lives in owned house			0.551
			(0.471)
Ownership unknown			0.233
			(0.674)
Has own room			−0.563
			(0.436)
Weeks on holiday last year			−0.125
			(0.079)
Difficulty to raise CHF 100			0.161
			(0.106)
Pocket money per week			−0.003
			(0.005)
Trust			−0.297
			(0.236)
Comprehension questions correct			0.088
			(0.399)
Class 10			0.016
			(0.401)
Class 11			0.841
			(0.607)
Track B			−0.922***
			(0.263)

Table A3. *Continued*

	(1)	(2)	(3)
Track C			-1.100^{***}
			(0.352)
Track E			-2.741^{*}
			(1.399)
Constant	16.620^{***}	16.236^{***}	22.298^{***}
	(0.252)	(0.397)	(4.066)
Pseudo R^2	0.01	0.01	0.03
Observations	977	969	824

Notes: Tobit regressions on individual most consistent switch points, identical to the specifications reported in Table 2. SEs clustered at the individual level. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A4. *Mean Values of Time Preference Parameter Estimates by Class Language, Consistent Choices Only.*

	FR	GE	GE-FR	p-value (robust)	p-value (clustered)	N
δ	0.844	0.875	0.031	0.022	0.244	482
	(0.140)	(0.127)	(0.027)			
β	0.996	1.021	0.024	0.132	0.196	467
	(0.168)	(0.135)	(0.019)			
β^*	0.310	0.200	-0.110	0.015	0.044	467
	(0.464)	(0.401)	(0.054)			
ρ	4.521	4.991	0.470	0.012	0.046	485
	(1.828)	(1.984)	(0.235)			

Notes: Consistent choices used as outcome variables, identical to the specifications reported in Table 3. 'FR' and 'GE' stand for French and German, respectively. 'p-value (robust)' provides p-values of two-sided mean difference t-tests of German versus French ('GE-FR') using heteroscedasticity robust SEs without clustering. 'p-value (clustered)' gives the respective p-values when clustering at the class level. Values in parentheses are SDs in the case of 'FR' and 'GE' and clustered SEs in the case of the difference 'GE-FR'. Here N gives the sample size.

Table A5. *Mean Values of Time Preference Parameter Estimates by Native Language, Consistent Choices Only.*

	FR	GE	Bi	GE-FR	p-value (robust)	p-value (clustered)	N
δ	0.868	0.879	0.874	0.011	0.527	0.615	427
	(0.128)	(0.130)	(0.117)	(0.022)			
β	0.996	1.016	1.010	0.020	0.364	0.399	417
	(0.165)	(0.142)	(0.140)	(0.024)			
β^*	0.314	0.216	0.216	-0.098	0.119	0.126	417
	(0.468)	(0.413)	(0.413)	(0.064)			
ρ	4.486	5.157	4.630	0.671	0.008	0.019	430
	(1.822)	(1.997)	(1.883)	(0.286)			

Notes: Consistent choices used as outcome variables, identical to the specifications reported in Table 5. 'FR', 'GE' and 'Bi' stand for French, German and bilingual, respectively. 'p-value (robust)' stands for two-sided p-values of mean difference t-tests of German versus French ('GE-FR'). 'p-value (clustered)' gives the respective p-values when clustering at the class level. Values in parentheses are SDs in the case of 'FR', 'GE' and 'Bi' and clustered SEs in the case of the difference 'GE-FR'. Here N gives the sample size.

Table A6. *Mean Values of all Covariates by Class Language.*

	FR	GE	GE-FR	*p*-value
Age	14.532	14.495	−0.037	0.919
Quiz correct	0.899	0.893	−0.006	0.847
Female	0.470	0.542	0.072	0.337
Born in Switzerland	0.879	0.928	0.049	0.179
Swiss	0.752	0.901	0.150	0.011
Number of siblings	1.497	1.464	−0.033	0.712
Attended pre-school	0.819	0.988	0.170	0.000
Mother's age	44.619	45.386	0.767	0.245
Father's age	47.514	48.168	0.655	0.180
Mother's native language: German	0.235	0.749	0.514	0.000
Mother's native language: French	0.530	0.150	−0.380	0.000
Father's native language: German	0.329	0.744	0.415	0.000
Father's native language: French	0.456	0.108	−0.349	0.000
Lives with parents	0.812	0.741	−0.071	0.031
Lives in rented house	0.094	0.078	−0.016	0.570
Lives in rented flat	0.275	0.187	−0.088	0.057
Lives in owned house	0.564	0.697	0.134	0.020
Has own room	0.905	0.928	0.023	0.273
Weeks on holiday last year	3.275	3.482	0.207	0.317
Difficulty to raise CHF 100	3.224	3.111	−0.113	0.412
Pocket money per week	17.495	16.722	−0.773	0.816
Saves part of pocket money	0.738	0.755	0.017	0.782
Attended course on money use	0.109	0.078	−0.031	0.483
Encouraged by parents: independence	0.743	0.833	0.090	0.034
Encouraged by parents: responsible behaviour	0.804	0.628	−0.176	0.000
Encouraged by parents: hard work	0.453	0.216	−0.237	0.001
Encouraged by parents: religious	0.101	0.052	−0.049	0.010
Encouraged by parents: unselfishness	0.277	0.432	0.155	0.023
Important quality for yourself: patience	1.859	1.818	−0.041	0.460
Important quality for yourself: readiness to take risks	2.336	2.334	−0.001	0.985
Important quality for yourself: thrift	1.918	1.725	−0.194	0.005
Important quality for yourself: willing to help others	1.732	1.278	−0.453	0.000
Important quality for yourself: future planning	1.784	1.892	0.108	0.191
Important quality for yourself: fairness/equality	1.723	1.353	−0.370	0.000
Important quality for yourself: openness/tolerance	1.698	1.626	−0.072	0.485
Trust	0.434	0.533	0.099	0.048
Risk aversion	4.541	4.988	0.448	0.050
Class 9	0.356	0.354	−0.001	0.995
Class 10	0.349	0.354	0.005	0.979
Class 11	0.295	0.291	−0.004	0.983
Track A	0.450	0.392	−0.058	0.794
Track B	0.463	0.380	−0.083	0.704
Track C	0.087	0.202	0.114	0.288
Track E	0.000	0.026	0.026	0.200

Notes: 'FR' and 'GE' stand for French and German, respectively. '*p*-value' stands for two-sided *p*-values of mean difference *t*-tests of German versus French ('GE-FR') and accounts for clustering at the class level.

Table A7. *Effect of Class Language Controlling for Socio-Demographic Characteristics.*

	δ			β			β^*		
	Coef	SE	*p*-value	Coef	SE	*p*-value	Eff	SE	*p*-value
German school language	0.038	0.018	0.036	0.020	0.013	0.114	−0.099	0.063	0.119
Female	0.002	0.016	0.876	0.003	0.014	0.813	−0.009	0.053	0.862
Age	−0.002	0.001	0.203	−0.000	0.002	0.908	0.000	0.003	0.994
Swiss	0.060	0.023	0.010	−0.045	0.028	0.105	0.086	0.059	0.144
Number of siblings	−0.003	0.006	0.635	0.004	0.008	0.643	0.000	0.025	0.999
Mother's age	−0.000	0.002	0.817	0.000	0.002	0.882	−0.002	0.007	0.713
Father's age	0.001	0.002	0.713	−0.001	0.002	0.803	0.000	0.007	0.962
Encouraged by parents: independence	−0.020	0.018	0.255	0.016	0.023	0.475	−0.048	0.065	0.461
Encouraged by parents: responsible behaviour	0.033	0.010	0.001	−0.014	0.016	0.389	0.022	0.047	0.644
Encouraged by parents: hard work	−0.005	0.016	0.758	0.013	0.015	0.403	−0.083	0.045	0.065
Encouraged by parents: unselfishness	−0.002	0.012	0.890	0.011	0.014	0.444	−0.026	0.046	0.571
Encouraged by parents: religiosity	0.036	0.022	0.106	−0.014	0.021	0.511	−0.018	0.064	0.773
Lives in rented house	0.036	0.037	0.323	0.013	0.058	0.821	−0.097	0.067	0.149
Lives in rented flat	0.004	0.037	0.907	0.020	0.065	0.762	−0.067	0.062	0.281
Lives in owned house	0.022	0.032	0.499	0.016	0.061	0.793	−0.146	0.076	0.055
Ownership unknown	0.012	0.051	0.809	0.004	0.081	0.964	−0.087	0.137	0.526
Has own room	−0.031	0.025	0.205	0.009	0.029	0.755	0.102	0.056	0.069
Weeks on holiday last year	−0.005	0.004	0.255	−0.001	0.007	0.846	0.004	0.014	0.761
Difficulty to raise CHF 100	0.008	0.005	0.073	0.000	0.007	0.952	0.004	0.020	0.855
Pocket money per week	0.000	0.000	0.862	−0.000	0.000	0.241	0.001	0.001	0.122
Risk aversion	−0.004	0.005	0.433	0.010	0.005	0.057	−0.013	0.015	0.392
Trust	−0.029	0.013	0.028	0.038	0.013	0.004	−0.054	0.047	0.246
Comprehension questions correct	0.015	0.020	0.432	−0.021	0.038	0.583	−0.024	0.051	0.645
Class 10	0.011	0.022	0.609	−0.023	0.023	0.324	0.064	0.047	0.172
Class 11	0.055	0.036	0.127	−0.029	0.045	0.517	0.113	0.114	0.321
Track B	−0.038	0.016	0.020	−0.011	0.011	0.324	0.015	0.058	0.799
Track C	−0.077	0.025	0.002	0.066	0.025	0.009	−0.057	0.064	0.375
Track E	−0.122	0.074	0.099	−0.025	0.069	0.718	0.037	0.133	0.781
Constant	1.082	0.229	0.000	1.010	0.335	0.003			
Observations		415			407			407	

Notes: Detailed results of specification (2) presented in Table 4. Sample contains observations with mostly consistent choices and non-missing values in the respective outcome variable, class language and control variables. Columns 'Coef' report OLS coefficients. Column 'Eff' reports average marginal probit effects. Columns '*p*-value' report *p*-values of two-sided hypothesis tests.

Table A8. *Effects of Class Language across Specifications: Consistent Choices Only.*

	(A) OLS/probit*		(B) Lasso	(C) GMM	
	(1) Risk	(2) Controls	(3)	(4) No controls	(5) Controls
δ estimate					
German class dummy	0.029	0.036	0.043	0.061	0.048
SE	0.025	0.018	0.030	0.031	0.022
Two-sided p-value	0.249	0.044	0.156	0.049	0.026
One-sided p-value	0.124	0.022	0.078	0.025	0.013
Observations	472	403	467		
β estimate					
German class dummy	0.020	0.021	0.020	0.029	0.030
SE	0.018	0.013	0.027	0.021	0.015
Two-sided p-value	0.267	0.115	0.463	0.169	0.039
One-sided p-value	0.134	0.058	0.232	0.085	0.020
Observations	459	452	342		
β^* estimate					
German class dummy	−0.109	−0.107	−0.126		
SE	0.053	0.065	0.070		
Two-sided p-value	0.041	0.099	0.082		
One-sided p-value	0.020	0.050	0.041		
Observations	459	392	452		
r estimate					
German class dummy				0.203	0.158
SE				0.075	0.055
Two-sided p-value				0.007	0.004
One-sided p-value				0.004	0.002
Observations				459	457

Notes: Sample contains observations with consistent choices and non-missing values in the respective outcome, language dummy and control variables. Control variables are identical to those in Table 4. In panel (A), estimates of δ and β are obtained by OLS, and the estimated coefficients on β^* correspond to the average marginal probit effects. The asterisk for panel (A) denotes that those regression specifications were pre-registered. SEs in all specifications are clustered at the class level.

Table A9. *Effects of Class Language among Students with Non-Missing Socio-Demographic Characteristics.*

	OLS	
	(1) Risk	(2) Controls
δ estimate		
German class dummy	0.025	0.038
SE	0.029	0.018
Two-sided p-value	0.380	0.035
One-sided p-value	0.190	0.018
Observations	415	415
β estimate		
German class dummy	0.029	0.020
SE	0.016	0.013
Two-sided p-value	0.062	0.114
One-sided p-value	0.031	0.057
Observations	407	407
β^* estimate		
German class dummy	−0.102	−0.099
SE	0.048	0.063
Two-sided p-value	0.033	0.119
One-sided p-value	0.016	0.059
Observations	407	407

Notes: Sample contains observations with German and/or French native languages, mostly consistent choices and non-missing values in the respective outcome, language dummies and socio-demographic characteristics used in the specification of the 'Controls' column. 'Risk': OLS regression of outcome on language with risk aversion and a dummy for missing risk aversion as controls. Same control variables as in Table 4. Effects on δ and β obtained by OLS. The estimated effects on β^* correspond to the average marginal probit effects.

Table A10. *Effects of Native Language among Students with Non-Missing Socio-Demographic Characteristics and Excluding Bilinguals.*

	OLS	
	(1) Risk	(2) Controls
δ estimate		
German language dummy	0.005	0.019
SE	0.023	0.020
Two-sided p-value	0.815	0.333
One-sided p-value	0.408	0.166
Observations	260	260
β estimate		
German language dummy	0.029	0.013
SE	0.019	0.012
Two-sided p-value	0.140	0.272
One-sided p-value	0.070	0.136
Observations	257	257
β^* estimate		
German language dummy	−0.099	−0.096
SE	0.057	0.078
Two-sided p-value	0.080	0.217
One-sided p-value	0.040	0.109
Observations	257	257

Notes: Sample contains observations with German and/or French native languages who are not bilingual, mostly consistent choices and non-missing values in the respective outcome, language dummies and socio-demographic characteristics used in the specification of the ‘Controls’ column. ‘Risk’: OLS regression of outcome on language with risk aversion and a dummy for missing risk aversion as controls. ‘Controls’: same control variables as in the ‘Controls’ column of Table 6. Coefficient estimates for δ and β obtained by OLS. The estimated effects on β^* correspond to the average marginal probit effects.

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