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Citation

De Wachter, L., Heeren, J., & Speelman, D. (2017). The influence of home language and school language on the academic language proficiency of first-year students in higher education: an explorative study, 49-60. Retrieved from <https://hdl.handle.net/1887/57209>

Version: Not Applicable (or Unknown)

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Downloaded from: <https://hdl.handle.net/1887/57209>

Note: To cite this publication please use the final published version (if applicable).

The influence of home language and school language on the academic language proficiency of first-year students in higher education: an explorative study.

L. De Wachter, J. Heeren, & D. Speelman

Introduction

In Belgium, an increasingly large and diverse group of students enrolls in higher education (Raad voor Nederlandse Taal en letteren, 2015). That diversity is reflected, not only in differences in socioeconomic background and prior education, but also in language proficiency (Peters & Van Houtven, 2010). The population of multilingual students and students with Dutch as a foreign language has increased over the past years. A stumbling block for many students, not only students with a different language background, is the academic language that is used in higher education (De Wachter & Heeren, 2013). Many universities and colleges have become more aware of the importance of academic language proficiency and develop language policies to support students in their academic careers (Bonne & Vrijders, 2016; Deygers & Kanobana, 2010). Language tests are among the instruments that are often used to develop these language policy frameworks, for example to gain insights into the language skills of students at the start of their education. Several institutions of the KU Leuven Association use the academic language proficiency (ALP) screening in the first weeks of their students first-year, since it has a proven correlation with academic achievement in the first year of study (De Wachter, Heeren, Marx, & Huyghe, 2013). In this article, we will look deeper into the ALP scores of starting students at the university and in the colleges to determine the effects of home and school language on that score.

The data for this study consists of the screening results of 9842 students in five higher education institutions in Flanders (KU Leuven, Odisee, UCLL, Thomas More Mechelen and Thomas More Kempen) between 2011-2012 and 2013-2014. This study will analyze students' ALP-score with a focus on the influence of home and school language. Central to the interpretation of the data is Cummins' distinction between 'Basic Interpersonal Communicative Skills' (BICS) and 'Cognitive Academic Language Proficiency' (CALP) (Cummins, 1979). Research into language acquisition of bilingual children shows that the ALP level in a second language depends on the acquired level in the mother tongue (L1). At the base of that statement is the 'Interdependence Hypothesis' and the 'Threshold Hypothesis' (Cummins, 1979). To explain, a high level of language proficiency in the mother tongue (= acquired threshold) allows for a similar level in a second language, while a less developed L1 limits the development in the second language (L2) (Cummins, 1979). Proficiency levels in L1 and L2 have an influence on each other (=interdependence). However, we will also look deeper into the limitations of this framework, especially the notion of a common underlying proficiency, and suggest an alternative interpretation of the data, using more recent insights from Hulstijn (2015). In this article we will discuss the ALP screening first; the focus will be on the underlying construct and validity. Secondly, the theoretical framework around academic language proficiency will be described, followed by the

analysis and results. To conclude, the results of the study around students' ALP-scores will be interpreted in the light of a critical view of the theoretical framework.

A valid ALP-screening

Academic language is defined in general as the language that is used in schools that helps students acquire and use knowledge (Van Dyk, 2015). It does not only provide access to the academic world, but is also necessary for academic achievement (Anstrom et al., 2010; Gee, 2008). Academic language or more specifically, academic Dutch as a unified concept does not exist: the academic language differs according to the specific discipline, subject matter and medium; it is one end of a continuum with informal, conversational language on the other end (Snow, 2010). There are, however, some characteristics that are considered to be aspects of ALP in general, such as: infrequent words, a formal tone, grammatically complex structures, an abstractness in content, links between textual parts that are sometimes left implicit and an impersonal style (Snow, 2010; Van den Branden, 2010).

The ALP screening developed at the KU Leuven is a low-stakes test, i.e. a test with a low impact on students' lives, which measures whether students are able to recognize and use these complex constructions and infrequent words in abstract language. Language that is too discipline specific, or technical, was avoided, since it would make the test less generally applicable. The ALP screening does not only test knowledge of academic language, but also another key component of language ability, i.e. strategic competence: "[...] a set of metacognitive components [...] which can be thought of as higher order executive processes that provide a cognitive management function in language use, as well as in other cognitive activities" (Bachman & Palmer, 1996, p. 70). To make the test tasks representative and authentic, texts and contexts were chosen that reflect the kind of language students might encounter in their first year, such as fragments of course syllabi (Sercu, Vyncke & Peters, 2003). The screening is administered within a secured online environment, has 25 to 28 items and lasts a maximum of 30 minutes, making it easy for the administration to provide the test to large groups and process the data afterwards. The items deal with vocabulary and reading skills and test students' knowledge as well as metacognitive strategies. The word items, for example, test whether or not a student can derive the meaning of a certain word from the context(s) in which it is given or other word forms as well. The reading items contain classical reading comprehension questions but also items that ask about the underlying text structure. Additional questions require students to drag and drop sentences into the correct order. Examples of test questions are included in the appendix.

To determine the academic level of the texts, the Flesch-Douma formula was used, which is an indication of text complexity. In addition, frequency lists and corpora were combined to determine the frequency of the words occurring in the texts and the number of word items (De Wachter & Heeren, 2013). In 2009, the ALP screening underwent an extensive pilot to check test-internal aspects such as item analyses and reliability. Further studies investigated the predictive validity of the screening instrument: in 2010 and 2011 a correlation study found a significant correlation between the average exam results in the first semester and the language test scores of 2660 KU Leuven students: $r=0.35$; $p<0.0001$ (De Wachter et al., 2013). The language test cannot be considered a very strong predictor of academic achievement, but it can select an at-risk group of students: 23% of the testers scored below the ALP screenings cut-off point and of these students, 72% scored less than 50% on average on their January exams. Students that score below a certain language proficiency threshold seem to have a higher risk of poor exam performance (De Wachter et al., 2013).

Multilingualism: a theoretical framework

To interpret the test results of monolingual and multilingual students, we will start from the theoretical framework of Cummins (1979; 1986). He uses the notion of bilingualism, but in this explorative study this will be considered as exchangeable with multilingualism, though researchers sometimes see these terms as different notions, with multilingualism specifically referring to proficiency in more than two languages (Saville-Troike, 2010). There is no single definition of multilingualism. Firstly, it is not always clear how proficient one must be in any of their languages to be considered multilingual or whether the same level of proficiency is required in every one of the four language skills (listening, reading, writing, speaking) (Edwards, 1994; Saville-Troike, 2010). Secondly, aside from linguistic definitions of the concept, political and cultural interpretations can also be used (Saville-Troike, 2010). This study, because of its explorative character, uses multilingualism in its widest sense as the mastery of two or more national languages; dialects and other linguistic variants are not taken into account, since their use will be mainly restricted to BICS.

Multilingualism and its perception have evolved throughout the years. Where at first it was considered as a negative property, from the sixties onwards, positive aspects of multilingualism came to the foreground (Bialystok, Martin, & Viswanathan, 2005). There is a link between multilingualism and other aspects such as cognitive performance (Woumans, Ceuleers, Van der Linden, Szmalec, & Duyck, 2015) or cultural capital (Agirdag & Vanlaar, 2016). Cummins warns for two unfounded hypotheses that, though they are refuted by scientific evidence, are often present in education. Firstly, the mismatch hypothesis argues that a difference in the language spoken at home and the language of schooling will lead to academic delay. Secondly, the maximum exposure hypothesis states that a student can only dispose of that delay by being exposed to the educational language only. These misconceptions are at the base of a misguided perception that there is a direct causal link between home language and poor academic performance, while home language is often only a proxy for other causal factors. Agirdag and Vanlaar (2016) state that ethnicity or amount of exposure to the school/second language can be considered as unmeasured variables that actually cause the aforementioned effects people wrongly adhere to a multilingual background. Cummins further notices that the negative consequences frequently ascribed to multilingualism are often linked to socioeconomic status (SES). Research by Van der Slik, Driessen, and de Bot (2006) shows that in primary education, SES influences school performance more than home language. Cummins and Swain (1986) add that it is the quality of the L1 input that matters and that that quality will be lower families with a lower SES.

Cummins' framework distinguishes 'basic interpersonal communicative skills' (BICS) on the one hand and 'cognitive academic language proficiency' (CALP) on the other. Two continua that define these two notions are 'contextualized' as opposed to 'decontextualized' and 'cognitively undemanding' versus 'cognitively demanding'. BICS are part of a contextualized and cognitively undemanding context, while CALP is usually more decontextualized and cognitively more demanding. As mentioned in the introduction, two hypotheses that come forth from this distinction are the 'threshold-hypothesis' and the 'interdependence hypothesis'. The first states that, to have a high proficiency in a second language, one has to have reached a certain threshold in his or her first language first. The second hypothesis states that certain aspects of proficiency, mainly aspects of CALP, can be transferred from one language to the other because they are part of a common cognitive base: the common underlying proficiency (CUP). Two distinctions that can be added to this framework are the notions of subtractive and additive bilingualism and balanced and unbalanced bilingualism.

Additive bilingualism takes place when a person adds another language to his repertoire without negatively influencing his first language. Subtractive bilingualism means that the second language negatively influences the proficiency in the first language. The prestige of the first language is an

important factor in this process (Cummins & Swain, 1986). In an ideal situation a language user is a balanced bilingual, who has equal mastery over his different languages. This is of course a hypothetical distinction, as a balanced bilingual probably does not exist in reality. Hulstijn (2015), for example, mentions Grosjean's (1989) critique of the notion of the balanced bilingual, and even questions the possibility of providing empirical evidence that such a state of bilingualism actually exists (Hulstijn, 2015). Nevertheless, the distinction allows us to state that some bilinguals can be considered more 'balanced' than others.

The framework Cummins provides is a useful one, but in order to apply it to the data in this study, we have to take into account its limitations and critiques. Hulstijn (2015) criticizes the notion of CUP: while some L1-strategies can be transferred to L2, especially when the L1 and L2 have similar writing systems and rhetorical conventions, the term 'shared skills' or 'shared competences' does more justice to the reciprocal relationship between L1 and L2. He also notes that for example, poor L1 readers, need not necessarily be poor L2 readers too: students can have compensatory mechanisms or can experience language loss in their L1 due to living in an L2 environment. He ascribes the associations between L1 and L2 to differences in literacy skills in both languages to "scholastic aptitude and time spent on intra- and extra-curricular literacy activities" which he argues are actually a reflection of people's SES and motivation to read and write (Hulstijn, 2015, p.132).

Analysis and results of the ALP-test scores

To investigate the effect of multilingualism on a student's ALP, this study uses the test results of 9842 first year students that participated in the ALP screening over three academic years (2011-2012, 2012-2013 and 2013-2014). In 2011, 2517 students participated from KU Leuven and Odisee, in 2012 there were 4485 participants from KU Leuven, Odisee, UCLL and Thomas More Kempen, and in 2013, 2840 students participated in the screening from KU Leuven, UCLL and Thomas More Mechelen. The total sample contains 4614 male students and 5228 female students; 6268 students studied at the university (KU Leuven), 3574 were enrolled in one of the colleges (Odisee, UCLL, Thomas More Mechelen, Thomas More Kempen). Before the test started, students filled in an electronic form where they reported on their home language use. 8417 participants indicated that they spoke Dutch only, 806 students indicated that they sometimes used another language at home but mostly Dutch and 619 students indicated that they rarely or never spoke Dutch at home. 8459 students had the same home and schooling language and 1383 students had a different home language than the language of schooling. Though linguistic realities are more complex, BICS will be associated with home language in this study, while CALP will be associated with school language.

A multiple regression analysis was performed on the student data, with the language test score set as the dependent variable. The independent variables were noted as gender, test version, institution (university or college), home language and whether or not a student's home language differed from their school language. The results of the regression are represented in Table 1.

The regression model is very significant, but has a relatively small predictive value with an R^2 of .16. Almost all independent variables contributed to the model. The interaction between the test version of 2012 and the institution is not significant, as is the interaction between gender and the test version of 2013. The test used in 2012 was somewhat easier to solve than the test used in 2013, which explains its significance. The ANOVA-table below shows which factors have a stronger influence on the variance in the ALP screening score: whether a student studies at the university or college is revealed as the strongest indicator, followed by the student's home language. Although home language has a significant main effect, there is a significant interaction between home language and a difference in home language and prior school language.

TABLE 1. Regression results

Variabele	Sum Sq	Df	F value	Pr(>F)
Institution	197821	1	1015.4814	< 2.2e-16 ***
HL	24786	2	63.6172	< 2.2e-16 ***
Gender	34781	1	178.5413	< 2.2e-16 ***
Test version	25403	2	65.2006	< 2.2e-16 ***
HL ≠ SL	1065	1	5.4685	0.01938 *
Institution - Test version	26376	2	67.6988	< 2.2e-16 ***
HL - HL ≠ SL	4745	2	12.1781	5.22e-06 ***
Gender – Test version	1402	2	3.5987	0.02739 *
Institution - HL ≠ SL	977	1	5.0162	0.02513 *
Residuals	1914346	9827		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

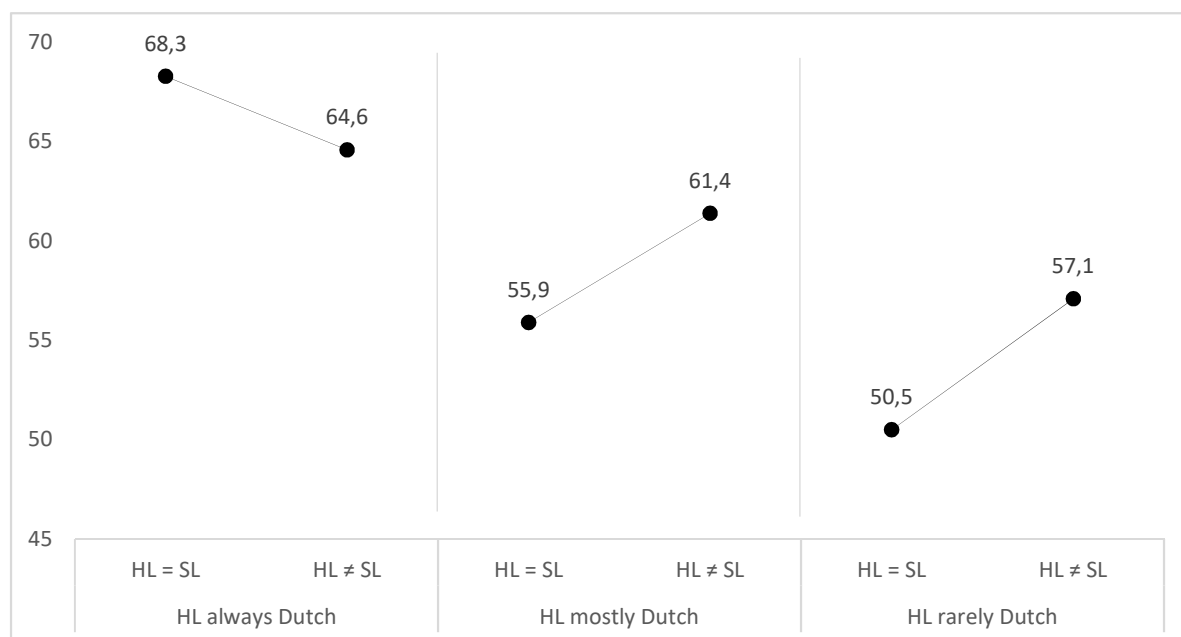
Residual standard error: 13.96 on 9827 degrees of freedom; Multiple R-squared: 0.1656, Adjusted R-squared: 0.1644 ; F-statistic: 139.3 on 14 and 9827 DF, p-value: < 2.2e-16

TABLE 2. ANOVA table

Variabele	Sum Sq	Df	F value	Pr(>F)
Institution	197821	1	1015.4814	< 2.2e-16 ***
HL	24786	2	63.6172	< 2.2e-16 ***
Gender	34781	1	178.5413	< 2.2e-16 ***
Test version	25403	2	65.2006	< 2.2e-16 ***
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Residuals	1914346	9827		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

Since this study wants to investigate the effect of home language (HL) and prior schooling language (SL) on ALP, we will focus on the interactional effect of home language and school language. When this effect is represented visually, the pattern below emerges from the data:



HL = Dutch HL = SL	HL = Dutch HL ≠ SL	HL = mostly Dutch HL = SL	HL = mostly Dutch HL ≠ SL	HL = rarely/ never Dutch HL = SL	HL = rarely/ never Dutch HL ≠ SL
n=8382	n=35	n=36	n=770	n=41	n=578
M=68.3%	M=64.6%	M=55.9%	M=61.4%	M=50.5%	M=57.1%

FIGURE 1. The effect of HL and SL on ALP.

The figure distinguishes between three groups: the students with Dutch as their HL, the students who speak mostly Dutch at home and the students who rarely or never speak Dutch at home. These groups also consist of two subgroups: one in which the students HL is the same as their SL and one in which there was a difference between HL and SL. In the two multilingual groups, the L2 was considered their HL, even when they indicated that they mostly spoke Dutch at home. What is striking is that the majority of students are monolingual Dutch-speaking students; they make up 85% of the entire population. The Dutch-speaking students that had their schooling in a different language and both multilingual student groups that had their schooling in their L2 are very small groups, resulting in a much wider error margin. The last two groups, multilingual students who reported that they received their secondary education in their own language are not studied in this article. The reason behind this is that these groups are not only very small, they are also very heterogeneous. They are on average much older (mean age = 22) and contain more students that have a foreign nationality.

One group that is small, but relatively homogeneous is the group that has the L1 as their HL, but had their secondary education in another language. They are on average between 18 and 19 years of age. It is interesting to look at their scores using Cummins' frame-work since the average ALP score is considerably lower (mean ALP score = 64.6%) than that of their Dutch-speaking peers that have had their education in Dutch (mean ALP score = 68.3%). This difference is only marginally significant, due to the large error margins.

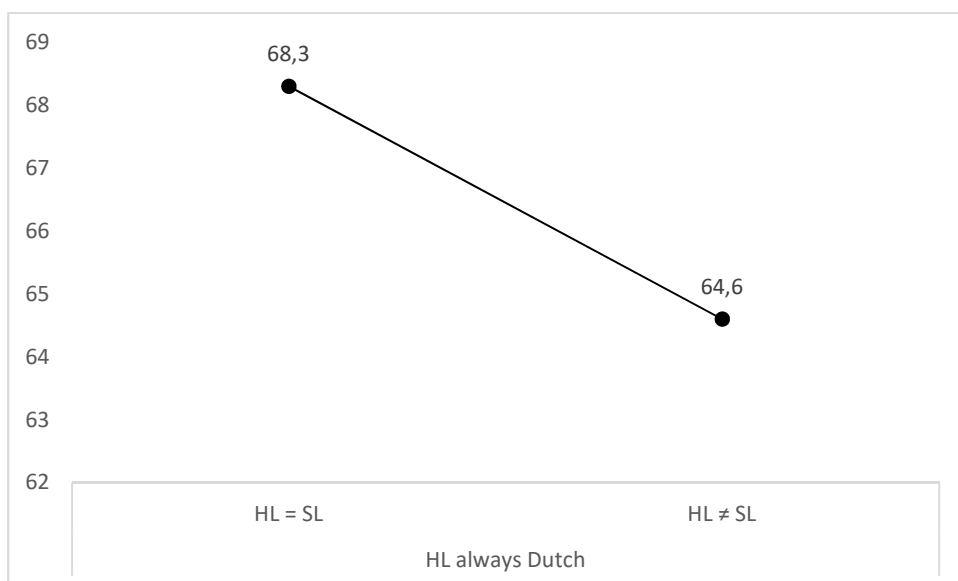
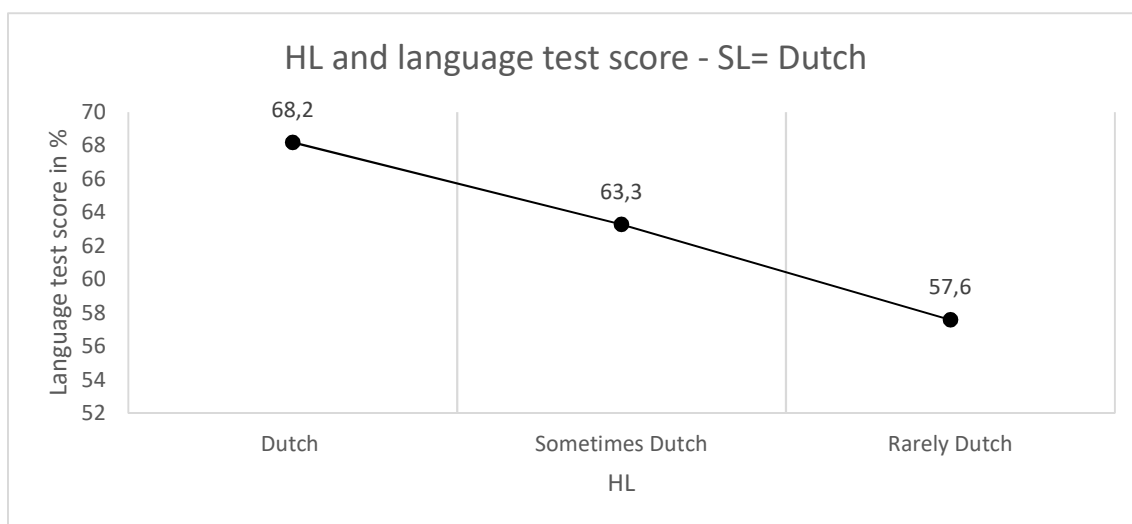


FIGURE 2. The interaction effect of HL and SL on ALP score for students with Dutch as their only HL

In addition to comparing groups that had the same HL and SL to groups that differed in HL and SL, it is also interesting to investigate the ALP scores of the students that had a HL different from Dutch but had Dutch as their SL. In the following analysis the two multilingual groups of students that had Dutch as their SL are compared to the monolingual L1 speakers that had Dutch as a SL. The average age of each of the three groups is between 18 and 19 and their nationality is mainly the Belgian nationality. Figure 3 represents the average scores of the three groups visually:



HL = Dutch SL = Dutch
Mean age = 18.7 Nationality = 98% Belgium 2% Netherlands
N=8179
M=68.2%

HL = mostly Dutch SL = Dutch
Mean age = 19.2 Nationality = 83% Belgium 7% Netherlands
N=747
M=63.3%

HL = rarely/ never Dutch SL = Dutch
Mean age = 19.4 Nationality 81% Belgium 2% Netherlands
N=572
M=57.6%

FIGURE 3. Average ALP scores of three groups of students with different HL situations but Dutch as their language of schooling

The graph shows, from left to right: the students who speak Dutch at home and Dutch as a SL (M 68.2%), the students that mostly use Dutch at home and had it as a SL (M 63.3%) and lastly, the students that rarely or never speak Dutch at home but had Dutch as their SL (M 57.6%).

Discussion

This study provides universities and colleges with useful information concerning the academic language proficiency, as operationalized in this ALP screening for starting first-year students having a multilingual background. These results might prove helpful in developing academic support for multilingual students, as well as gaining an insight into the academic language proficiency first-year student population. However, any causal links between multilingualism and language proficiency cannot be derived from the results. At first sight, they seem to confirm the mismatch hypothesis Cummins warns for. It appears that the larger the discrepancy between SL and HL, the lower students score on the ALP-screening. This phenomenon is found in multilingual students with Dutch as their SL as well as in native speakers who had their education in a foreign language. It would be too easy, however, to fall into the trap of the mismatch hypothesis, as several pieces of evidence that could exclude other possible explanations are missing in this explorative study. In essence, the results of this study lead to more questions than they provide answers. The results and the limitations of interpreting this data show a few important variables and considerations that are necessary when looking into the linguistic background variables of (starting) students in future research, certainly in relation to their ALP.

A first remark in this perspective would be that a diagnostic test could reveal more detailed data on specific language aspects that certain groups perform better on than others. The ALP screening is only a practical instrument that provides students with a rather rough indication of their ALP, combining a limited number of reading and word items. The results of the study should therefore be interpreted with this limitation in mind. Also, seen from a policy perspective, further research could also operationalize the variable 'school language' differently. In this study we coded our data based on the theoretical ideas of Cummins and made a distinction between a group that had a difference in school and home language and a group that had the same home and schooling language. However, while this is justified from an explorative point of view, the interaction variable becomes very complex since there is some conceptual overlap between the variable home language and the variable schooling language, i.e. home language is present in both variables. From a language policy perspective, it would also be interesting to operationalize the variable school language as 'Dutch' and 'other than Dutch'. The language policy in Flanders constitutes, for example, that students with a diploma in Dutch secondary education can enroll in a university study without further entry requirements.

Considering the results of this study, several considerations need to be taken into account. Firstly, for the L1-students that had their education in another language than Dutch the timing-argument has to be taken into account. Cummins & Swain (1986) state that it takes much longer to develop CALP than BICS in any language. Since the screening is deployed in the very first weeks of the academic year, these native speakers might have simply had the problem of adjusting to the new academic language variant of their HL. Further and more long-term research is therefore needed to study the evolution of this particular group of students in higher education. In light of the two multilingual student groups that had their education in Dutch, it would be presumptuous to state that their degree of multilingualism has a negative effect on their ALP. First and foremost, this study has no data on SES, which in the theoretical framework above proved to be a more important variable for which multilingualism is often a proxy. Using Cummins' framework, a lower SES will lead to a lower input quality in the L2-HL, which leads to an underdeveloped CUP resulting in a lower CALP. In the more recent views of Hulstijn, who does not use the notion of a CUP, the ALP-score differences might be

seen as a result of the fact that these students participated less in intra and extracurricular activities stimulating literacy in either language. This would often be paired with a lower SES environment that does not encourage these activities. Either way, not enough variables are known in this study to attribute the lower ALP-scores to the linguistic background of the students only. Further research should therefore always include a measurement of SES, which in addition might also explain (much of) the variance in the monolingual L1-speakers (Hulstijn, 2015).

Another important side note is that recent research confirms that in Flemish education, due to historical language issues, strong monolingual beliefs exist which often lead to a strong belief in the maximum exposure hypothesis (Deygers, 2017; Pulinx, Agirdag, & Van Avermaet, 2015). In Cummins' theoretical framework, when the different HL of students in secondary education is considered as something negative and in some cases even as forbidden, the discrepancy between HL and SL grows, resulting in a negative effect on their CUP, and as a consequence on their CALP as well (Pulinx, Agirdag, & Van Avermaet, 2015). A similar conclusion can be reached if CUP is left out of the equation: a student that has negative feelings about his SL will not be inclined to broaden his literacy activities in that language, certainly not when that student comes from a lower SES-background in which students are often not encouraged to do so. Therefore, these monolingual beliefs historically grounded in Flemish education might only strengthen the seeming mismatch hypothesis which in turn strengthens the belief in the maximum exposure hypothesis. There are, however, enough reasons mentioned in this discussion section not to interpret the results from deficit or mismatch perspective. Several studies indeed show that multilingualism, on the condition that it is additive and more balanced, has cognitive advantages (Agirdag & Vanlaar, 2016).

Conclusion

The main conclusion of this explorative study is that the results need to be interpreted with care. The ALP screening was developed to be a practical instrument giving students with a higher risk of not succeeding in their first year an early warning signal. This study wanted to further explore the effect of home language and languages of pre-higher education schooling on the ALP-score. This was done by performing a multiple regression analysis on a group of 9248 first year college and university students. The regression controlled for the following variables: gender, institution, test version, home language and difference in home and school language. This article also looked deeper into the interaction between home language and whether or not a student's HL and SL were different from each other. Students who indicated that they had only Dutch as their home language but had their education in another language scored lower on the language screening. Multilingual students who had their education in Dutch, scored lower on the ALP-screening the less they spoke Dutch at home. This information is useful for universities and colleges in the sense that these groups may need extra attention in a language policy, and in their student support systems, but at the same time it would be incorrect to perceive a single, direct causal relationship between multilingualism and ALP. It would be too easy to interpret these results as evidence for the mismatch hypothesis, since other factors, such as SES, are not taken into account in this explorative study. This study shows that further research is necessary to create a correct and adequate representation of starting, multilingual students' ALP and of the complex multilingual reality of this group of students. It is important not to fall into the trap of the mismatch hypothesis, often leading to the maximum exposure hypothesis, since the reality comprises of numerous factors.

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Appendix: ALP test items

Voorbeelditem 1: Lezen op tekststructuur

Lees de tekst. Teksten worden volgens bepaalde tekstpatronen opgebouwd. Volgens welke structuur is deze tekst opgebouwd?

“Met wetenschap wordt zowel bedoeld op bepaalde vormen van menselijke kennis als op het proces om hiertoe te komen als op de organisatie waarbinnen deze kennis wordt vergaard.

De wetenschappelijke wereld is dat deel van de maatschappij dat zich uitdrukkelijk ten doel heeft gesteld systematisch kennis te verwerven. De wetenschap heeft een eigen karakter wat blijkt uit haar methoden en conventies. De aldus ontwikkelde *wetenschappelijke kennis* vormt een specifieke reconstructie van een deel van de werkelijkheid en is opgebouwd met behulp van bepaalde wetenschappelijke methodes.

Wetenschap en technologie zijn bepalende elementen van de moderne geïndustrialiseerde samenleving en mede hierdoor beïnvloeden maatschappij, techniek en wetenschap elkaar sterk. Deze verweving maakt tegelijk dat het bij wetenschap in veel gevallen om meer gaat dan om kennisverwerving en reconstructie van de werkelijkheid. Veel wetenschap is er op gericht kennisverwerving te koppelen aan toepassing ervan. Niet louter reconstructie van de werkelijkheid maar ook constructie van de werkelijkheid is het doel.” (Bron: Wikipedia)

Welke structuur herken je in deze tekst?

- A een opsomming: beschrijven van een aantal elementen of kenmerken
- B chronologie: het beschrijven van een historische ontwikkeling
- C dit – tegenover – dat: elementen / systemen / structuren vergelijken
- D probleem – oplossing

Voorbeelditem 2: Het juiste synoniem

Lees de twee zinnen. Wat is het meest correcte synoniem van het aangeduide woord?

“Het geheel van regels en technieken dat hier wordt gebruikt, is het verwijssysteem dat momenteel aan het departement geschiedenis van de KU Leuven wordt gehanteerd en waarover een brede consensus bestaat.”

“De vergadering tussen vertegenwoordigers van de aftredende meerderheid over het bankgeheim is gisteren constructief verlopen. Er tekent zich een consensus af rond de opheffing van het bankgeheim.”

- A. verantwoordelijkheid
- B. gevoeligheid
- C. overeenstemming
- D. tevredenheid

Voorbeelditem 3: Alineaopbouw

Lees de zinnen van een tekst. Ze staan niet in de juiste volgorde. Sleep ze naar hun juiste plaats. Twee zinnen staan al juist.

Titel: Hersenen verwerken 100,000 woorden per dag

A Zij zijn van mening dat er nieuwe hersencellen ontstaan wanneer er steeds meer informatie binnenkomt.

B Dat is maar liefst 34 gigabytes per dag, hetgeen overeenkomt met een vijfde van de opslagcapaciteit van een computer.

C Die toevloed van informatie zorgt er volgens veel wetenschappers voor dat onze hersenen overbelast worden.

D Dat aantal vinden we in de resultaten van een nieuw onderzoek terug.

E Daardoor zou zelfs de structuur van de hersenen veranderen. Dat alles kan tot concentratieproblemen leiden.

1 Gemiddeld hoort of leest een volwassene 100.500 woorden per dag.

2 ...

3 ...

4 ...

5 ...

6 ...

7 Al zien sommigen de structuurveranderingen wel als iets positiefs.