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Exposure is not enough: The interaction of exposure and efficiency in the second language acquisition process

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Abstract

Exposure and efficiency are main determinants of immigrants' second language acquisition. In some studies also interactions between these two concepts have been reported but the empirical results are rather inconsistent and there has been no theoretical foundation of this interaction effect. But the existence and direction of this interaction may have serious consequences since it has direct implications for language learning programs. The determinants exposure and efficiency have recently been integrated in an expected utility framework by Esser (2006a, 2006b), which allows clear predictions about the impact of the concepts as well as their interdependences. The interaction between exposure and efficiency is tested empirically with German data from the project 'Preschool Education and Educational Careers among Migrant Children'. The theoretically derived hypothesis of a positive interaction between the two concepts can be verified. This indicates a Matthew effect which means that children who already have an advantage (e.g. have a higher efficiency) can benefit more from an additional positive condition (like more exposure). The multiplicative link of the two concepts also implies that a learner cannot reach a higher level in the second language, if just one of the determinants is very low.

Keywords: second language acquisition, children of immigrants, exposure, Matthew effect

Introduction

Fluency in the receiving country's language is a key qualification for immigrants' structural integration into the society of the receiving country. A positive association between second language skills and immigrants' educational and occupational success has been shown in various countries (Chiswick & Miller, 2003; Dustmann & Fabbri, 2003; Dustmann & van Soest, 2002). Therefore the question arises which factors influence the immigrants' second language acquisition process.

Second language (L2) acquisition has been studied in different fields of research.[1] Economic as well as linguistic and sociological models of second language acquisition have been developed (Chiswick & Miller, 1995; Klein and Dimroth, 2003; Spolsky, 1989). Albeit different in details and emphases, these models show great similarities in respect to their main determinants of second language acquisition. Three main factors for a successful L2 acquisition process can be identified: the motivation of the learner, the exposure to the second language and the learner's efficiency. These three main factors of L2 acquisition have recently been integrated into a broader theoretical model by Hartmut Esser using an expected utility framework (Esser, 2006a, 2006b). The L2 determinants can be understood in terms of utilities, expectancies and costs. This theoretical integration enables clear predictions for the L2 acquisition process including interactions between the theoretical constructs. However, a closer empirical examination of that model including theoretically derived interactions with more specific operationalisations of the theoretical constructs has not been done yet. The question of the interaction between exposure and efficiency in L2 learning is not just interesting from a theoretical standpoint but comprises important political implications. The direction of this interaction effect can give a clear hint under which conditions language programs are more likely to be successful.

[1] The receiving country's language is also denoted as L2 (second language) and therewith differentiated from the immigrants' native language L1 (first language).

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Second language acquisition of immigrants

Approaches in different disciplines

Second language acquisition is a special form of learning. For this learning process three main determinants have been discussed interdisciplinary: the motivation for language learning, the opportunity to get in contact with the language (exposure) and the efficiency in language learning (for a detailed description see Esser, 2006a, 2006b). These factors are mentioned in linguistic as well as in economic, and at least partly also in psychological models of second language acquisition (see Chiswick & Miller, 1995, 1998; Chiswick, Lee, & Miller, 2006; Klein & Dimroth, 2003; Spolsky, 1989; Gardner, 1985).

The *motivation* for language learning is seen as 'driving force' in linguistic and psychological approaches and considered as multidimensional (Klein & Dimroth, 2003, also see Gardner, 1985). In the economic model of Chiswick and Miller (1995, 1998) the *economic incentives* are the only motivational force in the L2 acquisition process. In this perspective the economic incentives to learn L2 arise from the higher (economic) utility that is associated with a higher level of L2 fluency (e.g. higher wage rate, higher chance of employment). This dimension of motivation is also addressed by Gardner (1985) in his concept of 'instrumental motivation'.

The *exposure* to L2 builds the second conceptual variable in the L2 acquisition process. In this aspect linguistic and economic models are very similar, although they use different terms (Spolsky, 1989; Chiswick & Miller, 1995). The basic idea is that the learner has to get into contact with the target language, to get 'input' (Klein & Dimroth, 2003) or be 'exposed' (Chiswick & Miller, 1995) to the target language respectively. Both models differentiate between formal and informal learning settings. Formal situations are the various institutionalized educational opportunities (e.g. language courses). Informal learning settings refer to 'natural' learning situations like in everyday situations or through the media. It is important to note that the kind as well as the intensity of this contact is relevant for the L2 acquisition process.

Finally the learner's *efficiency* also determines the L2 acquisition process. In the economic model of Chiswick and Miller this factor is quite technically described as the 'extent to which a given amount of destination language exposure produces language fluency' (Chiswick & Miller, 1995, p.250). Spolsky (1989) mentions individual 'capabilities' to be important for L2 learning. Some of these capabilities are considered as universal like an innate capability for deriving a grammar, an innate or learned capability for inferring interpretation from speech acts, and presuppositions about the uses of language. Other capabilities are more specific to the learner's individual background like previous knowledge, language learning aptitude, learning style and strategies as well as personality factors that may interfere with the learning process (e.g. anxiety).

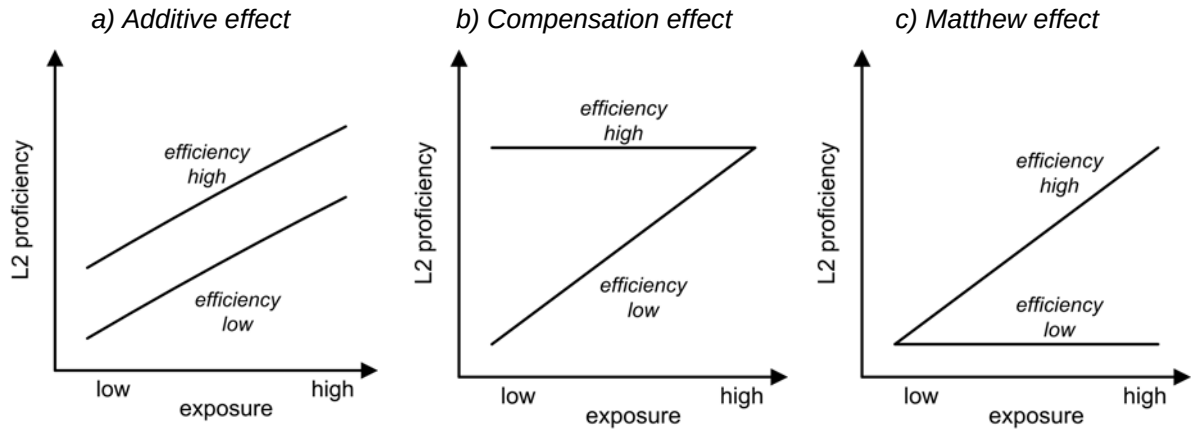
Possible interactions between the main determinants of L2

Given the interdisciplinary consensus about the significance of the three main determinants in the L2 acquisition process the question arises how exactly these factors work and interact with each other in the L2 learning process. Theoretically different mechanisms could be imagined. One could assume a pure additive influence of the three factors meaning that the three factors contribute to the L2 proficiency independently of each other. This possibility is graphically illustrated in figure 1a for the factors exposure and efficiency. In this case there is no interaction effect.

Another possible mechanism could be that a high value on one factor is a *sufficient condition* to reach a high L2 proficiency. This is shown in figure 1b: The highest level of L2 is reached as long as either efficiency *or* exposure is high (and this could also be extended to motivation). If this picture was true, this would mean a good message for compensation programs: It is enough to enhance just one factor and the learner will definitely reach a high L2 level. But even if one of the factors is low, there is still a chance to reach the highest L2 level depending on the other factors.

A third possibility is that all three factors are *necessary conditions* for L2 learning. This would imply that the L2 learning is impossible if one of the three factors is zero. Such an interpretation can be found by Klein and Dimroth (2003, p.141) who state that all three factors have to be given for language learning. For the interaction of exposure and efficiency this is also graphically illustrated in figure 1c. Here the learner can only reach the highest level of L2 if *both* exposure *and* efficiency are high (and also motivation in the full model). If only one of them is low, the learner remains at a lower level

of L2 proficiency. This is also an example of a *Matthew effect*: The individuals who are already in a favorable condition (like having more efficiency) can profit more from a second positive condition (like more exposure). Figure 1c would lead to a more pessimistic view of compensation programs. Here the message would be that it is not enough just to enhance one factor, but all have to be enhanced simultaneously.



Notes: Only the (possible) interaction between exposure and efficiency is shown here. An extension including motivation would be straightforward and include a three-way interaction in b and c.

Figure 1: *Possible associations between exposure, efficiency and L2 proficiency*

An integrative model of L2 acquisition and hypotheses

Hartmut Esser (2006a, 2006b) recently introduced an integration of these linguistic and economic L2 acquisition models into a broader theoretical model using an expected utility (EU) framework. The L2 acquisition is understood as an active investment of the learner and contrasted to a rather passive perpetuation of L1 only.[2] These two alternatives are denoted as L1 (only L1 perpetuation, status quo) and L2 (investment in additionally learning L2). An individual will choose between these two alternatives the one that maximizes the expected utility. To calculate the expected utility for the two alternatives, the evaluation of the status quo as well as the evaluation of a status that can be achieved by the investment in L2, the opportunities to reach the respective statuses and their costs, have to be considered. Following the usual EU framework, the L2 acquisition decision process can be formulated as follows (Esser 2006b, p.73-94):

(1) $EU(L1) = p(L1)U(L1) - C(L1) = U(L1)$

(2) $EU(L2) = p(L2)U(L2) + (1-p(L2))U(L1) - C(L2)$

The expected utility for the first alternative (equation 1) is equal to the returns of the status quo U(L1). The actor has already reached this status so the returns are sure and p(L1) can be set to 1 and no further costs C(L1) incurred. The expected utility in case of a L2 investment (equation 2) consists of the anticipated returns from that investment U(L2) weighted with the probability of success p(L2), the sure costs of the investment C(L2) and the returns of the status quo in case of a failure to learn L2.

An individual will invest in L2 learning if the expected utility of this investment is higher than the expected utility of the status quo (EU(L2) > EU(L1)). From the equations (1) and (2) this condition can be reformulated as:

(3) $U(L2) - U(L1) > C(L2)/p(L2)$

The difference U(L2) – U(L1) can be interpreted as investment motivation, which has to be higher than the investment threshold C(L2)/p(L2). The probability of a successful L2 learning p(L2) can be further

[2] Language learning can also be understood as rather passive and as an unintended by-product of other activities. But since the same determinants are relevant for this 'passive learning' as for the 'active investment', this differentiation will not be further addressed here.

differentiated in exposure to L2 and efficiency for L2 learning (Esser 2006b, p.75). Both conditions have to be met, that means that the learner needs contact to L2 but must also be able to use the given opportunities. This implies a multiplicative link between these two concepts and the model finally can be formulated as follows:

(4) $U(L2) - U(L1) > C(L2)/p(exp)p(eff)$

This modeling of the L2 acquisition process has several implications: 1.) The motivation to invest in L2 learning can be changed by either a change in the anticipated returns of that investment (U(L2)) or a change in the attractiveness of the status quo (U(L1)). 2.) The determinants motivation, costs, exposure and efficiency do not work in a simple additive way. If, for example, the exposure to L2 is very low, then the whole investment threshold is very high and the motivation of the learner must be especially high to overcome this investment barrier. If there is almost no exposure to L2, the investment threshold will tend to infinite and no L2 learning will take place – independent of the learning motivation. This means that the L2 determinants interact in a specific way with each other. Using M(L2) for motivation instead of U(L2) – U(L1), the equation 4 can be reformulated as:

(5) $M(L2) > C(L2)/p(exp)p(eff)$

$p(exp)p(eff)M(L2) - C(L2) > 0$

The last formula implies positive interactions between the motivation, the exposure and the efficiency. In a regression model three two-way interactions as well as a three-way interaction would be included and the model hypothesizes the regression coefficients of these interactions to be positive.

In this article only a part of this L2 acquisition model will be tested empirically. The dataset used here does not contain information about the learner's motivation, so this topic cannot be addressed in the analyses (but one may assume that the subjects of this study, 3-4 year old children, are all motivated anyway). Also the costs of L2 learning will not be treated here, since the children in this study learn the L2 in everyday settings and so monetary costs for language courses do not play a role. Other possible costs of L2 learning could occur in form of distances (e.g. linguistic distance between L1 and L2) (Esser 2006b, p.88), but these are assumed be equal for all children in the sample (all are children of Turkish immigrants). The focus of the following sections is thus on the relation between L2 exposure and the learner's efficiency as determinants of L2 proficiency, whereby the interaction between the exposure and the efficiency is of special interest. It is derived from the theoretical model that a successful L2 acquisition can only take place, if the exposure to L2 and the learner's efficiency are both high. This means that a high value on one of those variables cannot compensate for a lack of the other. This form of the hypothesized interaction effect is equal to figure 1c.

Data and operationalisations

The data for the empirical analyses are part of the project 'Preschool Education and Educational Careers among Migrant Children'. German and Turkish families with a 3-4 year old child were randomly selected from data of registration offices in 30 German cities and communities of a local region in South-West Germany. Turkish families were contacted by bilingual interviewers and the parents could choose their preferred language for the interview. After the parent interview, the standardized developmental test 'Kaufman Assessment Battery for Children' (K-ABC) was conducted with the child. The families were surveyed in the first half of the year 2007; a follow-up interview with the same families will take place in 2008. Altogether 1281 families were interviewed in the first wave of this study, but here only the sub-sample of 625 children with a Turkish migration background is used. After deleting the cases with missing information at the model variables, 550 cases remain for the analyses.

To have an as clear test of the theoretical L2 acquisition model as possible, only variables that can unambiguously be associated with either the exposure to the German language or the learner's efficiency are used. Only the sex and the age of the child (in month) will be additionally controlled in all models. So it is not the aim to explain as much variance of the L2 proficiency as possible but to test the impact of the model variables and especially their interaction. The operationalisation of the variables is presented next.

L2 proficiency (dependent variable): K-ABC expressive vocabulary test score

As a measure of the German proficiency the subtest 'expressive vocabulary' from the German version of the 'Kaufman Assessment Battery for Children' (K-ABC) is used (Melchers & Preuß, 2005). In this subtest, children were shown pictures of objects and asked to name these objects. The name of the objects had to be given in German, although the test instructions could be stated in either German or Turkish. The proportion of correct answers of that subtest (z-standardized) is used as dependent variable.

Exposure to the German language:

As indicators of exposure to the German language, the following variables are used:

- Frequency of parental communication to the target child in German:

  We want to know how often you use different languages when talking to *[target child's name]*. How often do you usually talk to *[target child's name]* in German? [1: never, 2: rarely, 3: about half of the time, 4: usually, 5: always]

- Frequency of communication in German when friends or relatives visit the family:

  Which language is usually used when relatives or friends visit you? How often is German used then? [1: never, 2: rarely, 3: about half of the time, 4: usually, 5: always]

- Target child's proportion of watching German programs on TV in comparison to Turkish programs:

  Does *[target child's name]* watch only German, predominantly German, about half of the time German and Turkish, predominantly Turkish or only Turkish programs on TV? [1: only Turkish, 2: predominantly Turkish, 3: half German, half Turkish, 4: predominantly German, 5: only German]

- Proportion of German friends in the social network of the target child:

  Think about the friends of *[target child's name]*, with whom he/she plays together. How many of those children are German? [1: none; 2: few, 3: about the half, 4: most, 5: all]

- Self-reported parental proficiency in the German language:

  How well can you speak German? + How well can you read German? (Mean of both items) [1: not at all, 2: a little, 3: moderate, 4: well, 5: very well]

All variables are coded in a way that higher values indicate a higher exposure to the German language.

Efficiency of the learner

As a measure of the child's efficiency, different subtests of the K-ABC measuring different cognitive skills are used (magic window, face recognition, gestalt closure, number recall). The test instructions could be given in either German or Turkish and also the answers of the child could be in either language. These subtests measure the sequential processing and the simultaneous processing skills of the children (for more details about these subtests see Melchers & Preuß, 2003). For each subtest the proportion of correct answers is calculated. Since all four subtest scores load on only one factor in a principal component factor analysis (eigenvalue: 2.22), only the arithmetic mean of all four subtest scores is used in the analyses.[3]

Results

Multivariate analyses are conducted to test the influence of exposure and efficiency on the L2 proficiency. For this purpose, OLS regressions with robust standard errors are calculated. The results are presented in table 1. In the first model all indicator variables of L2 exposure are added as separate explanatory variables. All variables show the expected effects. The frequency of the parental communication in German significantly enhances the child's German vocabulary knowledge. Also a higher frequency of German communication on occasions of visits from relatives or friends of the family has a

[3] If there is missing information in one subtest, the mean is calculated by using the other three subtests. If all four subtest scores were used separately, about 100 cases would be lost due to missing values. Since the results do not change, the version with only one overall score of cognitive skills is preferred.

positive effect on the child's German proficiency. Watching rather German than Turkish TV programs also positively affects the German vocabulary, as well as a larger proportion of German friends in the child's social network. The self-reported German language skills of the parent also show a significant positive effect. Altogether, 35.6 percent of the variance of the vocabulary test score can be explained in this model (a model with only age and sex can explain 6.8 percent of the variance). In the second model the impact of the learner's efficiency is demonstrated: The cognitive skills score has a large significant positive effect. This model can account for 26.5 percent of the variance.

Table 1: The impact of exposure and efficiency on L2 proficiency

	Model 1			*Model 2*			*Model 3*		
Sex (female)	*-0.04*	*(0.07)*		*-0.12*	*(0.07)*		*-0.08*	*(0.06)*	
Age in month	*0.06*	*(0.01)*	**	*0.02*	*(0.01)*	*	*0.02*	*(0.01)*	**
Frequency of parental communication in German	*0.18*	*(0.04)*	**				*0.17*	*(0.04)*	**
Frequency of communication in German at visits of friends/relatives	*0.14*	*(0.05)*	**				*0.10*	*(0.04)*	*
Proportion of German TV watching	*0.12*	*(0.03)*	**				*0.09*	*(0.03)*	*
Proportion of German friends	*0.18*	*(0.04)*	**				*0.17*	*(0.03)*	**
Parent's self-reported German proficiency	*0.08*	*(0.04)*	*				*0.05*	*(0.03)*	
Cognitive test score				*3.37*	*(0.30)*	**	*2.49*	*(0.25)*	**
Constant	*-4.19*	*(0.39)*	**	*-2.15*	*(0.37)*	**	*-3.42*	*(0.36)*	**
N	*550*			*550*			*550*		
R^2	*0.3561*			*0.2654*			*0.4558*		

Source: *Project "Preschool Education and Educational Careers among Migrant Children", own calculations*
Notes: *Un-standardized OLS regression coefficients with robust standard errors in parentheses*
** $p \leq 0.05$, ** $p \leq 0.01$*

In the third model all variables are added simultaneously. It is noticeable that the coefficients of the exposure variables hardly change. Only the self-reported German proficiency of the parent is not significant any more. This shows that in this model specification the effects of the exposure variables are quite independent of the children's cognitive skills. The effect of the cognitive skill score drops in comparison to model 2 (but still is large and significant). This can be interpreted in a sense that the more clever children also get more exposure to the German language and that a part of the efficiency effect in model 2 is due to this enhanced exposure. The exposure and efficiency variables altogether explain 45.6 percent of the variance of the child's German vocabulary.

Finally, the interaction between the exposure to the German language and the child's efficiency is tested. To do this, a summarized exposure score is calculated by adding all exposure indicators weighted with the regression coefficients of model 3. The same procedure is done with the efficiency variable for a better comparison of the two. Both indices are then centered around their means. When these new build indices are added instead of the separate variables, the same results emerge. This is demonstrated in the first column of table 2: The model 4 of table 2 and model 3 of table 1 are equivalent. Model 5 contains the interaction term of exposure and efficiency. This interaction effect proves to be positive and significant. The proportion of explained variance increases to 47.7 percent (+ 2.1 percent in comparison to model 4). This result supports the hypothesis that has been derived from the theoretical model: The positive effect of exposure is even more positive for learners with high efficiency (Matthew effect). Or stated the other way round: The positive effect of efficiency is larger for children who also have a high exposure to L2. This effect is graphically shown in figure 2.

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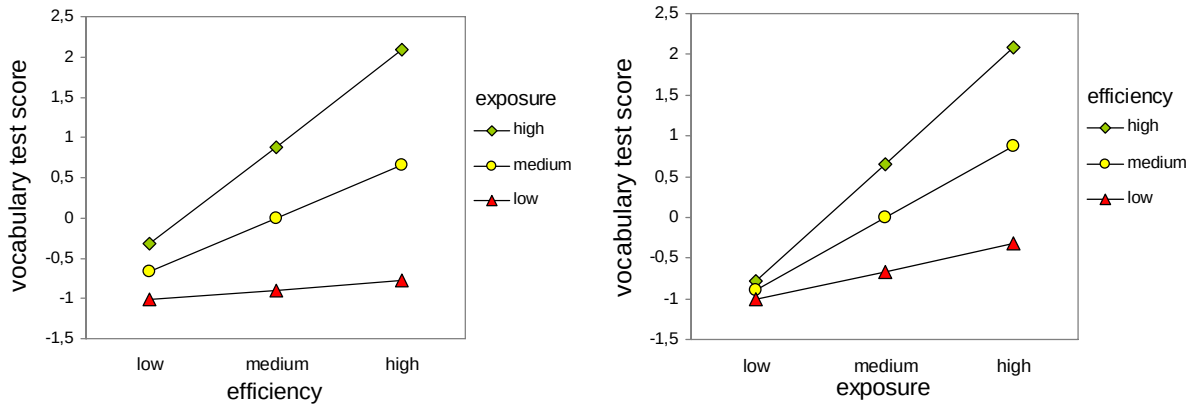
Table 2: *The effect of the interaction between exposure and efficiency on L2 proficiency*

	Model 4			*Model 5*		
Sex (female)	*-0.08*	*(0.06)*		*-0.06*	*(0.06)*	
Age in month	*0.02*	*(0.01)*	**	*0.03*	*(0.01)*	**
Exposure (weighted index)	*1.00*	*(0.07)*	**	*0.98*	*(0.07)*	**
Efficiency (weighted index)	*1.00*	*(0.10)*	**	*0.93*	*(0.10)*	**
Exposure x efficiency				*0.85*	*(0.15)*	**
Constant	*-0.93*	*(0.36)*	**	*-1.13*	*(0.36)*	**
N	*550*			*550*		
R^2	*0.4558*			*0.4766*		

Source: Project "Preschool Education and Educational Careers among Migrant Children", own calculations
Notes: Un-standardized OLS regression coefficients with robust standard errors in parentheses
** p≤ 0.05, ** p≤ 0.01*

It can be seen very clearly that the theoretically derived prediction of the multiplicative link between the two constructs holds: The higher the level of exposure, the steeper the line of the efficiency effect (first graph). If children have only very little exposure to L2, they have very low levels on L2 - independently of their efficiency (the regression line for the 'low exposure' condition is almost flat). The same is true for the exposure effect (second graph), but here the regression line for the children with low efficiency is not completely flat but still has a positive slope. A reason for this could be that learners with no efficiency at all are rarely found empirically, while a 'no exposure' condition is not so empirically unlikely.



Source: Project 'Preschool Education and Educational Careers among Migrant Children', own calculations
Notes: Predicted values from model 5, table 2 (for 42 month old boys): the label 'low' indicates values two standard deviations below the mean, 'medium' refers to mean values and the label 'high' indicates values two standard deviations above the mean of the respective variables.

Figure 2: *Interaction between exposure and efficiency*

Summary and discussion

The L2 acquisition model of Hartmut Esser (2006a, 2006b) has been introduced, that integrates different L2 approaches into a broader theoretical framework. An expected utility model is used to predict the impact of the L2 determinants as well as their interactions. The L2 determinants can be understood in terms of utilities, expectancies and costs. The basic idea is that an individual will invest in L2 learning if the expected utility of that investment is greater than the expected utility of the status quo (with only L1 mastery). The model allows a clear prediction under which conditions an individual will invest in L2: The investment motivation has to be greater than the investment threshold that consists of the ratio of L2 learning costs and opportunities. It is further assumed that both exposure to L2 and efficiency of the learner have to be given to provide these opportunities. Thus, in the formula of L2 acquisition there is a multiplicative link of the L2 determinants exposure, efficiency and motivation. This means that these variables do not just work additively, but that a successful L2 acquisition cannot occur if one of them is zero. In a regression, a positive interaction effect between all three constructs is expected.

A part of Esser's theoretical model has been tested in the empirical part of this article with data of the project 'Preschool Education and Educational Careers among Migrant Children'. In this project 3-4 year old Turkish children in Germany were tested with the 'Kaufman Assessment Battery for children' (K-ABC), which includes an expressive vocabulary subtest (used as dependent variable) as well as different subtests on other cognitive skills (used as a measure of efficiency). In the parent interview, several questions about the frequency of different language usage in different contexts were asked that give detailed information about the child's exposure to the German language. Both, the exposure to L2 and the child's efficiency, have proved to be very important determinants of the child's L2 proficiency. It has been demonstrated that the interaction between exposure and efficiency is also crucial. The interaction effect is significant positive and contributes to the explanation of L2 proficiency. This result supports the theoretically derived hypothesis about the interdependence of the model constructs. If either exposure or efficiency is very low, the individual cannot reach a high level of L2 proficiency. For an effective L2 learning, both conditions have to be present.

The algebraic sign of the interaction effect between exposure and efficiency is not just a theoretically interesting question but also bears strong practical implications for L2 learning. A positive or negative sign of the interaction effect is also linked with a more pessimistic or a more optimistic view of the L2 learning process. A negative interaction effect like in the study of Chiswick and Miller (1995) would offer a more optimistic perception of the L2 acquisition process (see figure 1b): The privileged individuals, who already score high on one of the L2 determinants, do not need much more; they will reach high L2 levels anyway. But for the more deprived individuals, who have low values on one of the L2 determinants, an improvement of the other condition can help them comparatively much. So compensational activities that enhance just one condition (like offering more exposure) are enough to yield relatively large gains for these individuals. The predictions are quite different, if a positive interaction of the L2 determinants is assumed (see figure 1c). In this case, an individual is restricted to relatively low levels of L2 as long as any of the L2 determinants is low. Learners who are already disadvantaged in some respect cannot gain that much from other positive conditions – in the extreme they cannot gain at all from a positive condition, because they are completely restricted by another bad condition (e.g. when individuals have no exposure to L2 at all, they cannot learn L2 – no matter how clever and motivated they may be). On the other side a Matthew effect can be found: Individuals who are already in an advantageous position (e.g. have high efficiency) can especially benefit from another positive condition (like more exposure). A high level of L2 can only be reached if both the exposure and the efficiency are high (and in the full model also the motivation). Thus activities that enhance only one of the L2 determinants will show only little effects as long as the other L2 determinants stay on a low level. This implies a rather pessimistic message since it seems much more difficult to improve more of the L2 determinants simultaneously.

The complete model of Esser is still not tested empirically. A dataset with (adult) L2 learners and detailed information about their exposure, efficiency and motivation, preferably also including a standardized language test with enough variance, is needed to test all interactions as well as the predicted three-way interaction. Also the model could be further differentiated, for example the exposure effect could by analyzed in more detail. Here it could be thought about an interaction of the quantity and quality of L2 input (cf. Becker, 2006). Another extension would be to look at the L2 acquisition process

in a longitudinal perspective. Here it could be studied in detail, which individuals are faster L2 learners and under which circumstances the learning growth is accelerated or hampered.

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