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Age at immigration and second language proficiency among foreign-born adults

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ABSTRACT

Sociologists typically assume that immigrants' acquisition of English as a second language follows the opportunities and motivations to become proficient in English, while many linguists argue that second language acquisition may be governed by maturational constraints, possibly biologically based, that are tied to the age at onset of language learning. In this article, I use U.S. census data to investigate the relationship between age at onset of second language learning and levels of English language proficiency among foreign-born adults in the United States. The overarching conclusion is that proficiency in a second language among adults is strongly related to age at immigration. Part of that relationship is attributable to social and demographic considerations tied to age at entry into a new country, and part may be attributable to maturational constraints. (Age at immigration, acquisition of language, English as second language, second language proficiency)*

When investigating second language (L2) acquisition among immigrants, sociologists and economists often rely on "exposure" or "human capital" frameworks, in which L2 learning is prompted by opportunities and motivations to become proficient in English. Much of this research shows that social and demographic factors, such as length of residence in the U.S. and educational attainment, strongly predict levels of proficiency in English among foreign-born adults. Linguists, by contrast, start from the premise that language acquisition is a multidimensional phenomenon to be explained through a combination of linguistic, neurolinguistic, and psycholinguistic processes. Much of their research suggests that L2 acquisition, like that of a first language (L1), is bound by maturational constraints which are tied to age at onset of language learning – typically measured through age at immigration – and which may be biologically based.

Each of these approaches has merits and failings. Linguists and psychologists empirically investigating the impact of age at immigration often use small, socially homogeneous samples of respondents, and so are unable to observe (or to control for) important social factors, such as educational attainment, which strongly

predict language proficiency. Sociologists, however, typically overlook the relationship between age at immigration and L2 proficiency. Neither approach takes into account the fact that age at immigration marks immigrants' life stages at the time of entry into the U.S., and so sets immigrants on certain life-course trajectories. Immigrants who enter the country during childhood, for example, are much more likely to attend an American school – an intensive learning environment dominated by English – than are those entering the country at older ages. Research that focuses on age at immigration, but neglects the links between age at immigration and life-course considerations, may overestimate the importance of age at immigration as a maturational marker; and research that focuses only on social and economic factors fails to leave open the possibility of maturational or other biological considerations in L2 acquisition.

This essay investigates the relationship between age at immigration and English proficiency in adulthood. I begin by describing the frameworks typically used – (a) by linguists and psychologists, and (b) by social scientists – to explain L2 proficiency among foreign-born adults. Based on census data, the analysis first describes the strong relationship between age at immigration and levels of proficiency in English among foreign-born adults in the U.S. Further analysis shows that the effects of life-course characteristics are substantial, although the direct effects of age at immigration on immigrants' levels of English proficiency in adulthood remain strong. The overarching conclusion is that L2 proficiency among adults appears to be strongly affected by age at immigration; part of that relationship is attributable to social and demographic considerations tied to age at entry into a new country, while part of it may be attributable to maturational constraints.

APPROACHES IN THE INVESTIGATION OF SECOND LANGUAGE ACQUISITION

Most of the research on language acquisition is undertaken by scholars in linguistics and psychology. Their major concerns are the neurolinguistic, linguistic, and psycholinguistic subprocesses underlying the acquisition of competency in various aspects of L2, such as phonology, syntax, lexicon, semantics, and communication. In contrast, sociologists and economists investigating L2 acquisition usually rely on human capital and exposure models, in which L2 learning is presumed to be the outcome of opportunities and incentives. I will briefly outline first the research concerning the possibility of maturational constraints in L2 acquisition, and then the sociological and demographic work on L2 proficiency among immigrants in the U.S.

Maturational constraints

A major impetus for linguists' investigation of maturational constraints in L2 acquisition arises from the strong possibility that maturational constraints govern FIRST language acquisition. Early theoretical frameworks concerning age-specific

constraints in language acquisition spoke of "critical periods" dating from developmental studies and from the work of Lorenz and others on "imprinting" (e.g. Lorenz 1965). Maturational constraints in L1 acquisition were first presumed to be biologically based and linked to neurological or quasi-neurological structures, e.g. the completion of hemispheric lateralization of the brain, myelinization of cortical cells, or decreasing plasticity of the brain. All these developmental processes occur sometime during childhood and are largely completed by puberty. More current work in this area speaks of "sensitive periods," "windows of opportunity," or "maturational constraints" that may be permeable to environmental influences and may have a probabilistic component.

Because almost everyone learns L1 during early childhood, and because there are obvious ethical considerations in manipulating the opportunity for people to learn L1, early behavioral evidence for maturational constraints in L1 acquisition rested on very selected evidence, such as the discovery of feral children or severely abused children who were denied the opportunity to learn any language. The most recent and famous of the feral child cases is that of "Genie" (Curtiss 1977), who was discovered after having spent most of her childhood in a bedroom, locked away from almost all human contact and communication. Other selected evidence comes from studies comparing the (re-)acquisition of L1 among people suffering major brain traumas in childhood vs. adulthood. Very recent and compelling evidence comes from comparing the acquisition of American Sign Language (ASL) among deaf children vs. adults.

The observations from these studies support the hypothesis that maturational constraints affect L1 acquisition. Thus "Genie" was never able to construct grammatically correct complex sentences, in spite of intensive attention and training after her discovery. Completeness of recovery from traumatic aphasia is directly related to the age at which the trauma occurred (Lenneberg 1967). People who learn ASL in adulthood as L1 or L2 are recognizably less facile than those who have learned it in childhood (Newport 1990). In general, people who are denied the opportunity to learn (or re-learn) L1 during childhood are unable to become fully fluent in various aspects of a language, even if given the opportunity to do so later in life.

Nevertheless, the biological and behavioral evidence for the existence of maturational constraints in L1 acquisition remains quite limited because opportunities to explore this relationship are so rare. Linguists have therefore turned to L2 acquisition, on the grounds that marshaling evidence for maturational constraints in L2 acquisition provides support for maturational constraints affecting L1 (but not vice versa). Although immigrants often undertake formal instruction in L2, studies show that age at immigration is a more powerful predictor of ultimate attainment than timing and extent of formal instruction in L2 (Patkowski 1980, Johnson and Newport 1989, Birdsong 1992). Migrants learning L2 in their new country thus embody a naturally occurring experiment in which age at immigration marks the age at onset of L2 learning.

The research concerning immigrants' ultimate attainment in L2 often shows that younger starters are advantaged relative to older starters in ULTIMATE attainment, (although not necessarily in INITIAL rates of attainment);[1] in several aspects of L2 proficiency, particularly phonology and syntax; and possibly in aural abilities as well.

Evidence for maturational constraints in phonology has been accumulating for several decades. Asher & García 1969 showed, for example, that the accents of 71 Cuban children aged 7–19, as judged by native English speakers from recordings, were strongly related to the children's age at entry into the United States. The highest probability of a child being judged as having "near native" pronunciation occurred for those who entered the U.S. between the ages of one and six, and who had lived in the U.S. for five or six years. Age at arrival was also related to self-reports of accent among a convenience sample of adult immigrants (Seliger et al. 1975). Among a sample of 60 adult, well-educated Italian immigrants in the U.S., pronunciation scores evaluated from taped speech samples showed a linear relationship between age at arrival and degree of accent (Oyama 1976). A recent study based on 240 adult native Italian speakers in Canada showed that the subjects' ages at time of first learning English systematically affected their production of English consonants – even though the subjects had, on average, lived in Canada for more than thirty years (Flege et al. 1995). Joseph Conrad is often alluded to as a well-known example of an excellent L2 learner who learned English later in life, but whose speech remained strongly accented (e.g., Scovel 1998, Bialystok & Hakuta 1994).

Research also strongly supports the hypothesis that maturational constraints govern learners' ultimate command of syntax in L2. A study of 67 adult middle-class immigrants showed, for example, that immigrants' age at arrival in the U.S. strongly predicted syntactic proficiency, with other independent variables (e.g. amount of formal instruction in English) showing very little effect (Patkowski 1980). In the frequently cited and critically acclaimed study of Johnson & Newport 1989 (cf. Long 1990, Bahrick et al. 1994; but cf. Bialystok & Hakuta 1994, Kellerman 1995, Bialystok 1997), which is based on a sample of Chinese and Korean immigrants associated with the University of Illinois, subjects were asked to judge the grammaticality of 276 sentences, of which about half were ungrammatical. The twelve rules of English grammar and morphology that were invoked included past tense, plural, third person singular, present progressive, determiners, pronominalization, particle movement, subcategorization, auxiliaries, yes/no questions, WH-questions, and word order (Johnson & Newport, 70–77). Their results showed a clear relationship between the immigrants' age at arrival and their command of English syntax and morphology, even after the amount and timing of their formal instruction in English were taken into account.

Finally, there is some evidence that age at onset of learning L2 influences people's ability to hear as well as to produce sounds and speech in L2. Thus Oyama's 1978 study of aural abilities among young adult Italian immigrants in

the U.S. showed that their ability to comprehend masked speech by native-born speakers was linearly related to the subjects' ages at immigration.

The general conclusion from this body of research, investigating the possibility of maturational constraints in L2 acquisition, is that only those who begin L2 learning as young children are certain of achieving "native-like" attainment, even after many years of exposure or opportunities to learn L2. The age-related loss in ability appears to persist through childhood, and perhaps through adolescence; it is gradual, rather than a catastrophic one-time event. L2 learners who start after the age of six or seven often become communicatively fluent, but they often retain measurable accents in phonology well into adulthood; with progressively older starts, they may end up with discernible "accents" in other linguistic domains as well, particularly syntax (e.g. Seliger 1978, Krashen et al. 1982, Singleton 1989, Long 1990).

There are, however, several major caveats to these general conclusions. The first concerns the nature of the supporting empirical evidence. First, the studies are usually based on convenience samples; thus Seliger et al.'s study sample (1975) consists of immigrants known by a class of students. Most study samples consist of respondents of the same linguistic group; they are typically, and often deliberately, limited to middle-class or well-educated respondents, to negate the effects of social and cultural factors (e.g. Oyama 1976, Patkowski 1980, Johnson & Newport 1989). When there is variance among the subjects' backgrounds, it is sometimes related to age at arrival in discomfiting ways. Thus Bialystok 1997 points out that the older-arriving respondents in Johnson & Newport's landmark study, most of whom were graduate students and faculty, had different English educational learning experiences than did the younger-arriving subjects, most of whom were undergraduates and who might have studied English grammar formally in the U.S.

Second, the results are often based on laboratory tests of a particular aspect of language proficiency, an approach that allows consistency and reliability across observations but lessens generalizability. Thus Oyama 1976 observed that, of the two speech samples obtained from her respondents – one in which the subjects recounted a brief anecdote about something frightening to them, and one in which the subjects read a short prepared paragraph – the subjects' "accents" were less noticeable in the more spontaneous speech example. Johnson's 1992 near-replication of Johnson & Newport's study was based on 21 of the original 46 subjects; it showed that the older-arriving subjects (but not the earlier-arriving subjects) performed much better when presented with written rather than auditory tasks. Furthermore, the observed effects of age at learning on L2 proficiency are often limited in scope, even within a particular linguistic domain. For example, of the 12 major grammatical rules tested by Johnson 1992, adult arrivals stumbled over only three rule-types (determiners, plurals, and subcategorization), but they performed similarly to early arrivals when confronted with the other nine rule types.

Some scholars have argued that the maturational constraints hypothesis implies that native-like attainment is unachievable by those who begin learning L2 in adulthood (Long 1990). Yet Birdsong's 1992 study showed that some nonnative speakers of French, who started learning the language after puberty, were indistinguishable from native French speakers in tests of syntax. In White & Genesee's 1996 study of 89 Canadians who learned English as L2 in adulthood, those whose English abilities were ranked very highly by two judges (e.g. pronunciation, morphology) were largely indistinguishable from native English speakers in terms of grammaticality judgments. Bongaerts et al.'s 1997 study showed that, among a highly selected sample of 10 native Dutch speakers, several were indistinguishable from native English speakers in English pronunciation.

A second major caveat is the lack of consensus about the mechanisms that cause age-specific or "maturational" constraints in L2 acquisition. For example, in earlier articles, Schumann 1975, 1986 argued that maturational constraints are shaped by social and affective considerations, i.e. "malleable" causes – a stance shared by Hakuta 1986. Newport 1990 argues that the age-related decline in L2 learning abilities occurs because of the expansion of non-linguistic cognitive abilities. Others argue that the relationship between phonology and age-at-onset of L2 learning is set up by phonological representation in the learners' native languages (Bialystok & Hakuta 1994, Leather & James 1991, 1996). Some linguists and psychologists reach back to theories of L1 acquisition and suggest that the apparent maturational constraints in L2 acquisition are the product of biologically based neurological processes, such as lateralization of the brain or myelination (Long 1990, Obler et al. 1991). Thus Pulvermüller & Schumann 1994 argue that two intertwined mechanisms explain the generally lower success of late L2 learners. The first is the ability to acquire grammatical knowledge, an ability that decays with the occurrences of myelination, or some other process of which myelination is a marker; the second concerns the role of motivation, which can ease language learning by virtue of the association of the cortical processes responsible for language acquisition with parts of the limbic structure that are strongly involved in emotion.

The wide range of processes posited as responsible for producing the native-like attainments of early L2 learners vs. the lower, although more variable, levels of proficiency among later L2 learners is partly a product of the obvious difficulties of directly observing the relationship between processes occurring in childhood, particularly neurological processes, and levels of L2 proficiency in adulthood (Flege 1987).

More generally, reliance on a given explanatory framework implicitly dismisses other explanations (Snow 1983, Schumann 1993). Searching for neurological, cognitive, or linguistic explanations – with a corresponding lack of emphasis given to social factors – stacks the evidence against social phenomena associated with age at arrival in the new country, and toward the possibility of maturational constraints (Flege 1987, Bialystok & Hakuta 1994, Long 1995). Yet

immigrants' age at entry in their country of destination is strongly related to social characteristics such as amount and type of schooling in L2 and social and demographic research provides evidence that L2 proficiency among adult immigrants is strongly predicted by these considerations.

Opportunities and rewards for L2 acquisition

Sociologists, economists, and demographers, in contrast to linguists and psychologists, have relied on secondary data and have generally used exposure and human capital frameworks to understand variation among immigrants' levels of proficiency in L2. Acquisition of L2 is largely viewed as a function of the accumulation of exposure to opportunities to hear, learn, and use the language, and of the anticipated rewards for investing in L2 learning. Recent research (e.g. Espenshade & Fu 1997) views immigrants' participation in various social contexts and institutions – which provide differing opportunities to hear, learn, and use the language – as following predictable patterns across immigrants' life-course.

Length of residence in the U.S. is often used as a simple and direct measure of immigrants' exposure to opportunities to learn the language (e.g. Jasso & Rosenzweig 1990); but some social scientists, including sociolinguists, note that length of residence may reflect the general opportunities and pressures on immigrants to acculturate to various aspects of American society (Schumann 1986, Portes & Rumbaut 1990). In spite of this blunt equating of time lived in the U.S. with opportunities to learn English, the empirical research by social scientists has generated remarkably consistent conclusions. Adult immigrants who have been in the country for longer periods of time demonstrate or report (i) higher levels of overall proficiency in English, (ii) higher levels of proficiency in some aspect of English, or (iii) higher frequencies of using English vis-à-vis another language, than those who have been in the country for shorter periods (Grenier 1984, Loo 1985, Jasso & Rosenzweig 1990, Stevens 1992, 1994, Lindstrom & Massey 1994, Espenshade & Fu 1997).

Sociologists have begun to refine measures of "exposure" by considering societal contexts in which L2 learning and use may be differentially encouraged; and economists have begun to include background and contextual factors as measures of the relative costs and benefits of learning L2. For example, an immigrant child living in a household in which English is spoken (particularly by a native speaker) may have a much easier time learning English as an additional language, or perhaps as his only language, than one growing up in a home in which no one speaks English (Hakuta & D'Andrea 1992, Portes & Schauffler 1995). Immigrants from Spanish-language countries are also more likely than those from other non-anglophone countries to have less pre-immigration exposure to English. The respondent's gender may also be an important consideration, because males and females often participate in different social environments, and these

different environments are implicated in immigrants' levels of English language proficiency in adulthood (Stevens 1986, Stevens & Meiller 1995).

Numerous studies have shown that educational attainment is strongly associated with immigrants' levels of proficiency in English, but the interpretation of that relationship varies. For example, a detailed study of proficiency in English among a sample of Japanese immigrant children showed that years of schooling in the U.S. were strongly associated with their skill in English (Okamura-Bichard 1985). A recent study based on longitudinal data from the High School and Beyond Survey shows that English skills strongly affect the likelihood of immigrant children's graduating from high school (White & Kaufman 1997). Sociologists interpret the positive association between educational attainment and English proficiency as (a) reflecting length of participation in an anglophone-dominated environment, (b) the added cognitive skills relevant to L2 learning gained from more schooling, or (c) selection processes in which those with better English skills achieve more schooling (Stevens 1994, Warren 1994, Espenshade & Fu 1997). Economists, however, interpret the relationship between educational attainment and English language proficiency as reflecting the higher relative costs of poor English skills among the better educated (e.g. Grenier 1984, Grin 1990).

Domestic settings and participation in formal social institutions in early adulthood also influence immigrants' English skills. Immigrants with a foreign-born or non-English-speaking spouse may lack the opportunities – and necessity – to practice their English skills in the home (Stevens and Schoen 1988, Espenshade & Fu 1997). Young adult immigrants in the U.S. who are enrolled in school may have acquired English skills in the U.S., or may have been accepted into American programs of study on the basis of established English skills. Finally, the positive relationship between participation in the formal labor force and immigrants' levels of proficiency in English has been well documented (Jasso & Rosenzweig 1990, Espenshade & Fu 1997).

When compared to the smaller-scale studies by linguists and psychologists, the studies by sociologists, economists, and demographers have some advantages and some disadvantages. They are typically based on large national surveys, or on census data; thus they include respondents from a wide range of social and cultural backgrounds. However, the reliance on survey data requires that L2 skills be measured through global self-assessments of proficiency or usage of English. Reliance on the exposure or human capital frameworks has also meant that important variables have been omitted, or relationships misspecified. In particular, these studies have avoided investigating the role of age at immigration in adults' English proficiency. Some major studies omit the variable "age at immigration" altogether (Chiswick 1993, Lindstrom & Massey 1994); others use broad categories that contrast immigrants entering the country in childhood with those entering in adulthood (Stevens 1994, Espenshade & Fu 1997).

There are two reasons to include age at immigration in investigations of immigrants' L2 proficiency. First, including age at immigration, by virtue of mea-

suring age at onset of L2 learning, allows the investigation of maturational constraints. Second, many of the social and demographic variables included in previous investigations (e.g. amount and location of schooling, spousal characteristics, and formal adult roles) are strongly related to age at immigration. For example, immigrants who enter the country very early in life are educated in the U.S. in an English-dominated school system; thus they are likely to complete a relatively high level of schooling, likely to form important social relationships with native English speakers (and thus to marry a fluent English speaker), and are likely to participate in U.S. society's social institutions, such as the formal labor force. Conversely, immigrants who enter the country later in life are likely to have less education, and to have completed their education elsewhere, and they are more likely to have married before arrival in the country. Thus age at immigration may be strongly associated with English proficiency in adulthood because it is strongly associated with immigrants' life experiences in social settings and institutions that differentially encourage or discourage L2 learning.

ANALYSIS FRAMEWORK

My analysis of immigrants' levels of English proficiency is undertaken from a largely sociological point of view. I use 1990 U.S. Census data to model the relationships between a set of social characteristics and levels of proficiency in English among adult immigrants. First, however, I concentrate on the relationship of immigrants' levels of proficiency in English in adulthood to length of residence in the U.S. and age at immigration. Information from linguistic studies and from statistical inspection of the data is used to specify the relationships. I then show that the strong relationship between age at immigration and proficiency in English in adulthood is partly attributable to the fact that age at immigration streams immigrants into different life paths, which have strong consequences for their levels of proficiency in English later in life.

Data and methods

The data are from the 1% Public Use Sample drawn from the 1990 U.S. Census (published 1993). Unfortunately, the census lacks retrospective information on immigrants' linguistic characteristics at time of entry in the U.S., and on the immigrants' L1, childhood language, or "mother tongue." One remedy is to infer immigrants' prior knowledge of English from the language characteristics of their countries of birth. The analysis sample thus includes only immigrants from countries in which English is neither a dominant language nor an official language (see Stevens 1994 for a list of these countries).

The dependent variable: Proficiency in English. The census schedule asked respondents a short series of questions about their language characteristics. If respondents indicated that they spoke a non-English language at home, they were then asked if they spoke English "not at all," "not well," "well," or "very well."

Because of the streaming question, immigrants who spoke only English at home were not asked about their proficiency in English, but it is probable that most were fluent in English. Excluding them from the analysis would therefore severely underestimate levels of English language proficiency among foreign-born adults. To avoid this bias, all respondents who reported speaking only English at home were assumed to speak English "very well."[2]

The question on proficiency in English was based on immigrants' self-reports (and inferred high levels of proficiency for respondents using only English at home), and it is global with unspecified referents. It thus lacked detail about proficiency in various aspects of English (e.g. syntax or phonology). However, although some researchers have expressed concern about the validity of self-reports of language usage (Shuy 1981), other research shows strong correlations between self-reports and objective measures of L2 characteristics (Fishman 1969, Hakuta & D'Andrea 1992, Birdsong 1992).

Independent variables. The 1990 Census also contains information on the time period that a foreign-born respondent entered the U.S. I estimated the number of years that a respondent had lived in the country, as well as the respondent's age at immigration, by comparing the time period of immigration with the date of the census and respondent's age at the time of the census, respectively. These estimates are problematic for older immigrants who indicated that they entered the country "before 1950" – the earliest possible response category. To alleviate these problems, I restricted the analysis to foreign-born adults aged 18 to 40. This age restriction means that foreign-born respondents in the analysis who immigrated before 1950 must have entered the country during infancy.

Relationships between age at immigration, length of residence in the U.S., and proficiency in English. Because of the varying assumptions in linguistic research about the nature of these relationships, I explored a large number of options. The dependent variable, i.e. level of proficiency in speaking English, has four outcome categories: (a) not at all, (b) not well, (c) well, and (d) very well. Because the distances between the categories are unspecified (how much better is "not well" than "not at all"?), it is best to explore the observed probabilities of respondents reporting one level vs. the others. I therefore plotted age at immigration by the probabilities of immigrants reporting each level of English language proficiency within each category of the variable "length of residence in the U.S.," and vice versa. I experimented with several different forms of the relationships between these variables (e.g. linear, inverse logarithmic, inverse square root, and non-continuous). I also allowed the forms of the relationships to vary over different parts of the range of each variable. I used the measures of the "fit" of the equations as one criterion to evaluate the different functional forms; I also inspected the metric coefficients of all variables in the models for reasonableness and practicality.

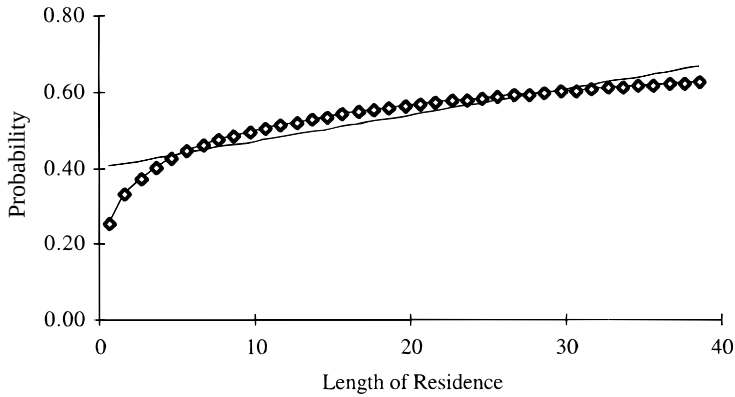

FIGURE 1: Relationship between the probability of respondents reporting their level of English proficiency as "very well" and length of residence in the U.S.

These exploratory investigations showed that the relationships of the probabilities of respondents reporting the various levels of English proficiency – with respect to years in the U.S. and age at immigration, respectively – are quite stable; and that they are curvilinear. Figure 1 shows, for example, the fitted observed relationship (denoted by a line linking small boxes) between the probability of respondents reporting that they speak English "very well" and length of residence in the United States. The relationship is logarithmic, with large increases in the probabilities of respondents reporting that they speak "very well" corresponding to small increases in length of residence during the first few years of residence, followed by smaller and smaller increases in the probabilities as years of residence stretches into decades.

The curvilinearity means that it is inappropriate to use statistical techniques that assume linear relationships between the dependent and independent variables to analyze the data. The gaps between the curve and the straight line superimposed on the curve in Fig. 1 show the types of error – the overestimation of probabilities reporting "very well" at the lower AND upper reaches of length of residence, and the underestimation in the middle range – that would occur if the relationship were assumed to be linear rather than curvilinear in the analyses.

It is possible, however, to transform logarithmic relationships into linear ones by taking the natural logarithm of the values of the independent variable (Weisberg 1985). Figure 2 shows how taking the natural logarithm of the values of "length of residence" transforms the curvilinear relationship into a linear one. The decreasing gaps between the data points, as length of residence increases, show the main benefit of this transformation. More weight is given to changes in length of residence for lower values, say between two and five years of residence

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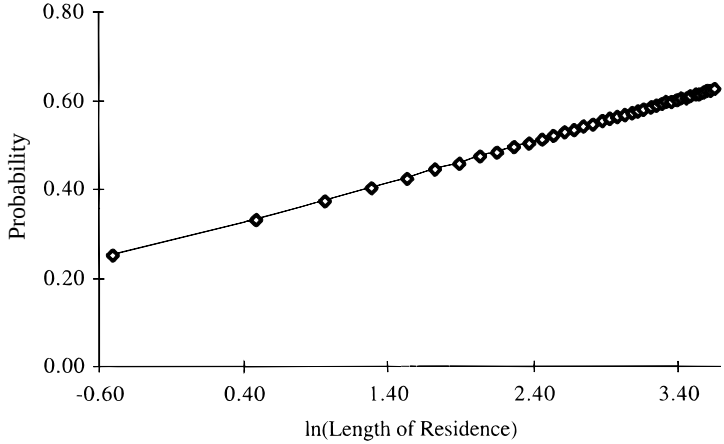

FIGURE 2: Relationship between the probability of respondents reporting their level of English proficiency as "very well" and the natural logarithm of length of residence.

(.69 and 1.60 after being logged) than between 12 and 15 years of residence (2.48 and 2.71 after being logged), in the estimation of the linear relationship. It is easy to transform the relationship back into the observed curvilinear one by undoing the arithmetic and taking the natural exponent of the natural logarithm of the values of length of residence.

Methods. I use ordered (ordinal) logit models to analyze the data because they take into account the intrinsic ordering of the categories of the dependent variable without imposing arbitrary intervals between the four categories (Liao 1994). In this approach, the dependent variable is considered to be the underlying tendency of y_i, often denoted as y_i^*. The values of the underlying tendency on the dependent variable run from low to high through the *J*-ordered categories, in this case the four ordered categories of English proficiency. Thus respondents with a very low underlying value on English proficiency would report the lowest category "not at all." As their level of proficiency improved, they would at some point cross a threshold, and would switch from reporting "not at all" to reporting the next higher category, "not well." As respondents' level further increases, they might cross another threshold; they would then report the next higher level of proficiency, "well." With further increases in proficiency, they could cross the threshold to the highest category, and so report "very well." With four possible response categories, there are three thresholds, and therefore three threshold parameters (κ_1, κ_2, and κ_3) to be estimated. Respondents whose underlying level of English proficiency fell somewhere be-

tween the first and second thresholds, (κ_1 and κ_2), would thus report their proficiency as "not well."

In general, the ordered logit model thus assumes that the probability (Pr) that respondent *i* reports the *j*th category of English proficiency

$$= Pr\,(\kappa_{j-1} \leq y_i^* < \kappa_j) \text{ where } \kappa_0 \text{ and } \kappa_4 \text{ are set to } -\infty \text{ and } +\infty \text{ respectively.}$$

The underlying tendency of y_i, y_i^*, is then modeled as a function of a set of k independent variables (X_k), slopes (B_k) and an error term (ϵ_i) which is assumed to be logistically distributed. Thus the probability that respondent *i* reports the *j*th category of English proficiency is estimated as

$$= Pr\,(\kappa_{j-1} \leq (\Sigma X_{ki} B_k + \epsilon_i) < \kappa_j)$$

where X_{ki} refers to the values for respondent *i* on the set of k independent variables, B_k refers to the values of the estimated slopes for the k variables, and ϵ_i refers to the value of the error term for the *i*th respondent.

ANALYSIS RESULTS

Means and standard deviations

Means and standard deviations for all variables are shown in Table 1. Although the analysis sample is limited to immigrants from non-anglophone countries, over 40% of the respondents reported speaking only English at home (and thus were considered to speak English "very well"), or explicitly reported that they spoke English "very well." Another 22% reported speaking English "well," leaving only 31% of foreign-born adults who reported that they spoke English "not well" or "not at all."

Because of the age criterion for inclusion into the analysis sample, the respondents range in age from 18 to 40, and were on average about 28 years old. On average, they had been in the U.S. for about 12 years and had entered the country in late adolescence. The standard deviation of age at immigration is quite large, with large proportions of respondents entering the U.S. during infancy, childhood, adolescence, and young adulthood. On average, the immigrants had not quite completed high school, and more than half appear to have completed at least one year of schooling in the U.S. More than half the immigrants were married, with about 20% living with a native-born spouse, and about one-third living with one who was foreign-born. The female respondents had, on average, 1.4 children. Most of the immigrants were employed in the labor force, although a substantial percentage (25%) were enrolled in school at the time of the census.

Table 2 shows the estimated threshold parameters and metric coefficients for the independent variables in a series of four ordinal logistic models. All estimated slope parameters refer to the change in the log odds of respondents reporting a higher vs. a lower level of English proficiency (i.e. crossing a threshold), given a unit increase in the independent variable. Models 1–2 show the zero-order effects

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TABLE 1. *Means and standard deviations for the characteristics of foreign-born adults in the United States (N = 8,046).*

Variables	Proportion or Mean	Standard Deviation
Level of Proficiency in English		
Very well	.46	
Well	.22	
Not well	.20	
Not at all	.11	
Residential Variables and Age		
Years in U.S.	11.56	8.70
Age at immigration	17.00	9.14
Age	28.49	6.88
Gender and Family Background		
Gender (female = 1)	.47	.50
Born in a Spanish-language country? (yes = 1)	.54	.50
Educational Characteristics		
Years of education	11.11	4.44
Attended school in U.S.? (yes=1)	.54	.50
Current Family Characteristics		
Number of children ever-born (women only)	1.41	1.51
Married to native-born spouse? (yes = 1)	.20	.40
Married to foreign-born spouse? (yes = 1)	.32	.47
Not married (yes =1)	.48	.50
Current Major Activity		
In labor force? (yes = 1)	.59	.49
Enrolled in school? (yes = 1)	.25	.44
Other activity? (yes = 1)	.15	.36

of years of residence in the U.S. and age at immigration. Each of the coefficients is large and statistically significant, although the zero-order effect of age at immigration is much larger in magnitude than the zero-order effect of years of residence. The large and negative coefficient for age at immigration to the U.S. suggests that the older the respondents were at time of migration, the lower the likelihood that they reported a higher (rather than lower) level of proficiency in English in adulthood. The positive coefficient for years in the U.S. suggests that the longer immigrants have been the country, the more likely it is that they will report a higher rather than lower level of proficiency in English.

Because changes in log odds are difficult to interpret, Figures 3 and 4 show the fitted probabilities generated by Models 1 and 2 respectively.[3] For each value of the independent variable, the probabilities sum to 1.00. Figure 3 shows that the probabilities of respondents speaking English "very well" are close to

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TABLE 2. *Metric coefficients from ordered logit models predicting level of proficiency in English among foreign-born adults in the United States.*

	Model			
Independent Variables	I	II	III	IV
Residential Variables				
Age at immigration (ln)	−1.201***		−.882***	−.492***
Years in U.S. (ln)		.383***	.427***	.684***
Background Characteristics				
Gender				.130*
Born in Spanish-language country?				−.969***
Educational Characteristics				
Years of education				.155***
Attended school in U.S.?				.453***
Current Family Characteristics				
Married & spouse is native-born[a]				.414***
Married & spouse is foreign-born[a]				−.657***
Number of children ever-born[b]				−.116
Current Activity[c]				
Enrolled in school				.213*
In labor force				.255**
Thresholds: κ_1	3.374	−1.789	.916	−1.969
κ_2	4.858	−.782	2.043	−.540
κ_3	6.600	.882	3.482	1.274

***$p < .001$
**$p < .01$
*$p < .05$
[a]Omitted category is "not currently married."
[b]For women only.
[c]Omitted category is "other activity."

1.0 for those who immigrated in infancy, and slope down precipitously as age at immigration increases through childhood and adolescence. Meanwhile, the probabilities of respondents reporting that they speak English "not well" or "not at all," although starting out very low, steadily increase as age at immigration rises. The precipitous decline in the probabilities that respondents report speaking English "very well" as their ages at immigration increase during early and middle childhood mirrors Johnson & Newport's graph (1989:87) of the relationship between immigrants' scores on a 276-item test of English syntax and their ages at immigration. Figure 3 also suggests that there is no abruptly defined "critical" or sensitive period in L2 learning; instead, there appears to be a steady decay, beginning in childhood and reaching into young

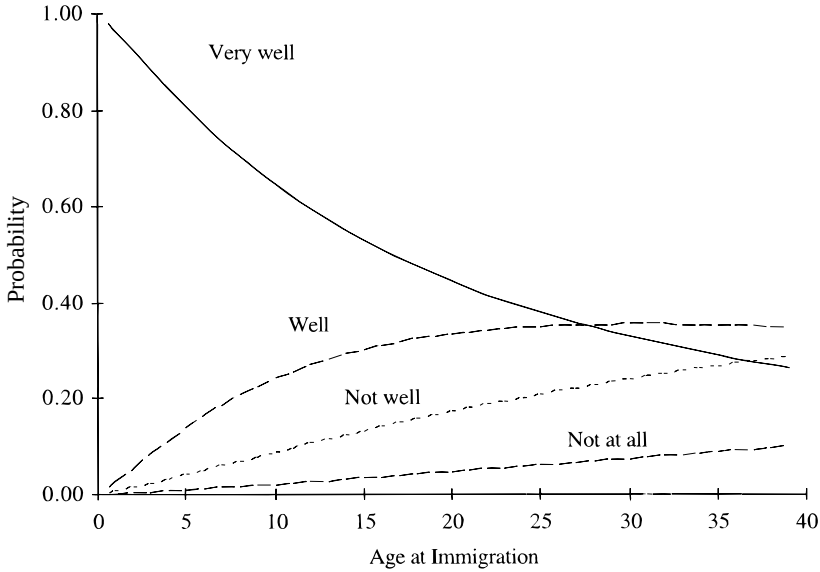

FIGURE 3: Zero-order relationships between the probabilities of respondents reporting each level of English proficiency and age at immigration.

adulthood, in the probability that immigrants report high levels of L2 proficiency in adulthood.

Fig. 4, which focuses on the impact of length of residence in the U.S. on proficiency, presents a very different overall picture. The probabilities that respondents speak English "very well" slide upward with years in the country; but the probabilities that respondents reported speaking English "not at all" or "not well" or "well" slide down as their years in the U.S. increase. This pattern of results supports the supposition that learning L2 is quickest within the first handful of years – although the figure also suggests that progress in L2 proficiency continues beyond those years, albeit at a slowing pace. The slope of the lines in this graph are much less dramatic than those in Fig. 3, reflecting the much lower impact of years of residence (rather than age at immigration) on level of proficiency. These two figures parallel the common emphasis in linguistic research on the effects of age at immigration on L2 proficiency, and the common emphasis in social demographic research on length of residence.

Model 3 in Table 2 contains the coefficients from an ordered logistic model showing the NET effects of years in the U.S. and age at immigration on the log odds that respondents report speaking a higher (rather than lower) level of proficiency in English. Both coefficients remain large and statistically significant – although the effect of age at immigration has shrunk, and that of residence has

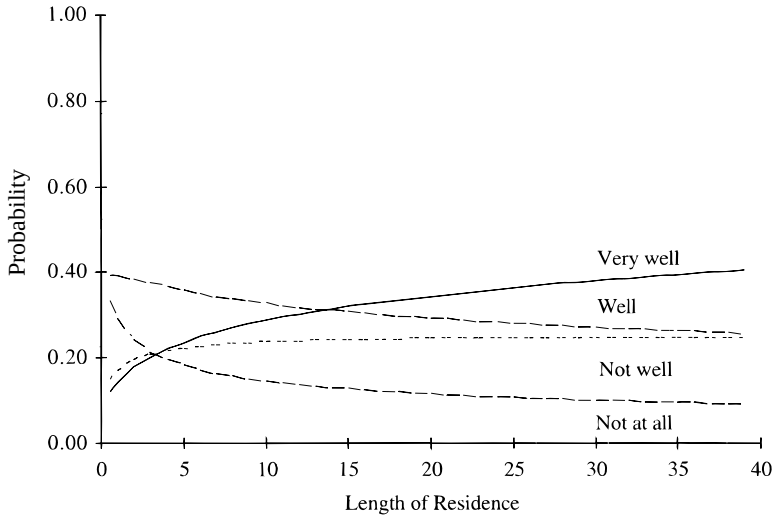

FIGURE 4: Zero-order relationships between the probabilities of respondents reporting each level of English proficiency and length of residence in the U.S.

grown, relative to their zero-order effects. These results thus suggest that the emphases in the linguistic studies on age at onset of learning L2, and in the sociological studies on the effects of length of residence in the U.S., are well placed. The results provide implicit support both for the maturational constraints hypothesis in linguistic research and for the exposure framework in sociological and demographic research. Unlike previous sociological research, however, these results demonstrate a strong relationship between L2 proficiency in adulthood and age at onset of L2 learning NET of the effects of length of residence, and a strong relationship between L2 proficiency in adulthood and length of U.S. residence NET of the effects of age at immigration.

Yet age at immigration, here used as a proxy for age at onset of English language learning, may be strongly related to immigrants' participation in age-graded social institutions and contexts that are closely associated with opportunities and motivations to learn English. The impact of age at immigration may thus be the result of age-graded social phenomena. In the last part of the analysis, I add a set of variables that summarize the immigrants' life courses.

Proficiency in English and life-course considerations

Model 4 in Table 2 adds in the effects of background and demographic variables (whether the respondent is from a Spanish-language vs. another non-anglophone

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country, and whether female or male); educational characteristics (years of education, and whether the immigrant attended school in the U.S.); current family characteristics (number of children and marital status); and current major activity (in the labor force, in school, or engaged in some other activity).

The background variables are statistically significant predictors of English language proficiency in adulthood. Thus immigrants from Spanish-language countries report lower levels of proficiency in English than immigrants from other non-anglophone countries. More highly educated immigrants report higher levels of proficiency in English than less educated immigrants. Foreign-born adults who completed at least some schooling in the U.S. are about 1.5 times as likely to report a higher level of English proficiency than those who completed their formal education before entering the country.

Some researchers have argued that children "anglicize" the household and teach or introduce their parents to English; however, the results of my analysis suggest that the presence of children in the household has little effect on their mother's level of proficiency in English. Immigrants with a native-born spouse report higher levels of proficiency in English than those who are not married; and those with a foreign-born spouse, who is very likely to share the respondent's non-English language, are apt to report lower levels of proficiency in English. Immigrants enrolled in school or in the formal labor force report higher levels of proficiency in English than those whose major activity is "other."

After we control for immigrants' background, educational characteristics, and family and activity characteristics, we find that the effect of years of residence in the U.S. increases. Meanwhile, the effect of age at immigration has further diminished, although it remains statistically and substantively significant.

Figures 5 and 6 show the net relationships of level of proficiency in English to age at immigration and to years in the U.S., respectively, controlling for all other social and demographic independent variables. Although almost all the background variables have large and statistically significant effects, the results portrayed in Fig. 5 still show a strong relationship between proficiency in English and age at immigration. The probabilities of immigrants speaking English "very well" in early adulthood still slope precipitously downward as age at immigration increases through the childhood years. The probabilities of immigrants speaking English "not well" or "not at all" climb with age at immigration. The overall ties between age at immigration and proficiency in English are still strong, although they are less striking than those presented in Fig. 3.

Figure 6 shows the pattern of relationships of proficiency in English to years in the U.S. net of age at immigration, and to the social and demographic variables. In contrast to the effect of age at immigration (which lessens as other variables are taken into account), the pattern of relationships involving length of residence becomes more marked as other variables are controlled for. Much of the effect of years of residence in the U.S. is still concentrated within the first five years or so

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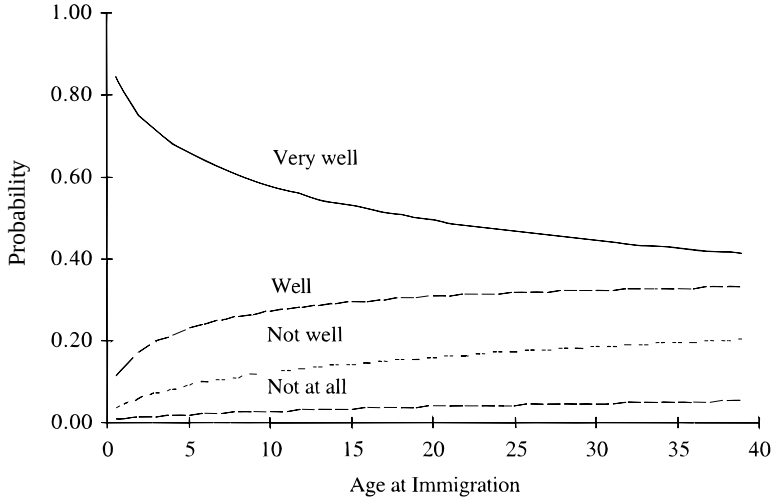

FIGURE 5: Predicted probabilities of immigrants speaking English "very well," "well," "not well" or "not at all" by age at immigration to the U.S. net of length of residence and other social and demographic variables.

after arrival in the country; however, the probability of immigrants speaking English "very well" steadily increases past two decades of residence, while the probabilities of immigrants reporting each of the lower levels of proficiency steadily creep downward.

SUMMARY AND DISCUSSION

The major question raised here concerns an important issue in linguistics and psychology: Do maturational constraints tied to age at onset of language-learning govern L2 acquisition? The results of this analysis, based on a large national sample of immigrants from a variety of countries, show a clear and strong impact of respondents' ages at onset of L2 learning (estimated through age at immigration) on their levels of proficiency in English in adulthood. The pattern of results accords with linguists' general observations: Very young learners, starting before age five or so, are almost certain to report being proficient L2 speakers in adulthood. The decay in L2 learning appears to start in early childhood and to continue through childhood and adolescence.

Further analysis showed, however, that the effects of age at immigration on English proficiency are tempered by immigrants' other characteristics. When we take into account length of residence in the U.S. along with features of the im-

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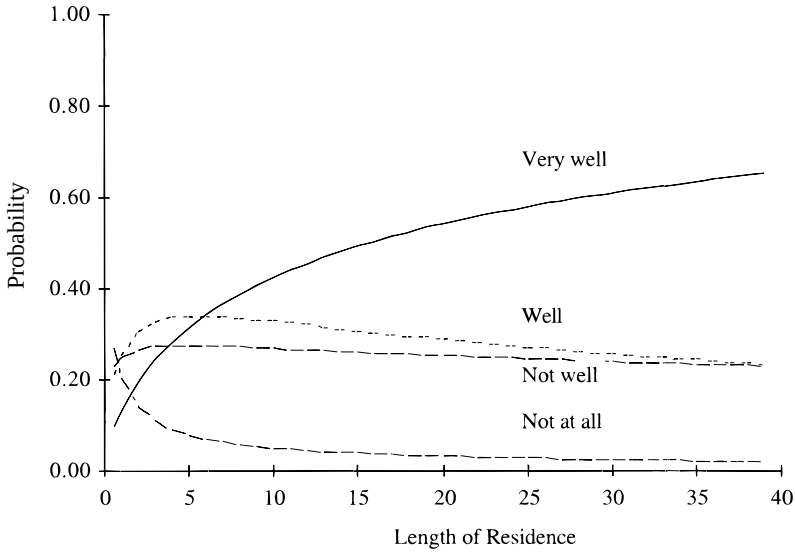

FIGURE 6: Predicted probabilities of immigrants speaking English "very well," "well," "not well" or "not at all" by years of residence in the U.S. net of age at immigration and other social and demographic variables.

migrants' family background, educational history, and current familial and activity characteristics, then the direct effects of age at immigration on English proficiency in adulthood lessen. These results suggest that age at immigration is related to level of proficiency in English in adulthood in large part because the timing of immigration within the life-course sets immigrants onto certain life-course trajectories. For example, immigrants who enter the country earlier in life are more likely to go school in the U.S., and are more likely to marry a native-born American, than those who enter the country at older ages.

The importance of these life-course variables in the prediction of English proficiency among adults highlights the benefits of considering language acquisition as a social process. Learning L2 at any age requires exposure to the language, motivation, and opportunities to practice receptive and active skills. In short, language learning requires communicative and social interaction. The large variance in levels of English proficiency among older immigrants arriving in the U.S. fits well with the idea that fluency in L2 largely follows (or is followed by) participation in settings that encourage the learning of English. Furthermore, an analysis based on cross-sectional rather than longitudinal data can only hint at the dynamic and irreducibly social processes that may intertwine increasing English

skills with increasing participation in social settings that demand or encourage English skills. It is thus probable that most investigations of L2 learning underestimate the importance of social processes.

But the continued substantive and statistical importance of the relationship of age at immigration to level of English proficiency in adulthood net of a variety of influential social and demographic variables – particularly educational attainment – is noteworthy. Controlling for family background, educational, and current familial and activity characteristics should slant the results in favor of social phenomena. If, for example, maturational constraints tied to age at onset of L2 learning prevent or deter older immigrants arriving in the U.S. from furthering their education because of language difficulties, then controlling for educational attainment in the statistical analyses will depress the estimated effect of age at immigration.

The approach followed in this analysis is therefore, in some senses, a conservative test of whether maturational constraints affect ultimate levels of achievement in L2 acquisition. Statistical analyses of secondary data cannot, however, ascertain causality. Nor can statistical analyses choose among unobservable causal mechanisms when one or more appear to have left footprints in the data. Analyses of secondary data are further hampered by the measurement of important concepts. In particular, the self-assessments of English proficiency that are found in U.S. census data are undoubtedly linguistically naive, and may have little to do with the specifics of grammatical or phonological performance on tests or in laboratories. Thus the results of the analysis say nothing about the processes that might be producing maturational constraints – whether neurological, cognitive, social, or some combination – nor do the results say anything about the specific linguistic phenomena that might be affected by them.

Because different methodological approaches have differing strengths and weaknesses, comparison of results across disciplines has numerous advantages. Studies by linguists and psychologists that investigate the possibility of maturational constraints typically include detailed and sophisticated measures of various aspects of L2 proficiency (e.g. syntax or phonology), but they are usually based on small and socially homogeneous samples of respondents. This approach, which focuses on immigrants in similar circumstances and contexts, highlights the total relationship between age at immigration and proficiency in L2 in adulthood, but at the expense of observing or controlling for the influences of social and demographic characteristics (such as educational attainment) that are tied to age at immigration. In contrast, the study reported here is based on a large national sample of respondents from a wide variety of social and ethnic backgrounds; the approach allows a sophisticated statistical analysis, although the dependent variable, English language proficiency, is self-assessed and global. While this approach cedes the rich language-specific detail gathered in the laboratory or through direct observation, the results clearly underscore the impor-

tance of social and demographic characteristics in predicting adults' L2 proficiency, as well as a persisting effect of age at immigration. The results of the two approaches are thus complementary; together they provide strong evidence that age at onset of learning L2 – as measured by age at immigration – very strongly influences immigrants' ultimate attainment in a L2.

NOTES

* Many colleagues, spread across several disciplines, provided valuable comments on this research. Among them were Cynthia Fisher, Nancy Garrett, Susan Gonzo, John Hagan, Charles Hirschman, Tim F. Liao, Michael Long, John Mardeen, Madonna Harrington Meyer, C. Gray Swicegood, and Jack Veugeler.

[1] Research often shows that adult learners initially learn L2 more quickly than child learners (e.g. Krashen et al. 1982; Snow 1983; but see Singleton 1989 for a critical review of research on this issue). In this article I focus on ultimate attainment.

[2] See Espenshade & Fu 1997 for a detailed investigation of, and reliance on, this assumption.

[3] Recovering the fitted probabilities from the estimated parameters in an ordinal logistic model requires undoing the arithmetic associated with the logistically distributed error term; see Liao 1994 for details.

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