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Lexical attrition in younger and older bilingual adults

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Abstract

Healthy monolingual older adults experience changes in their lexical abilities. Bilingual individuals immersed in an environment in which their second language is dominant experience lexical changes, or attrition, in their first language. Changes in lexical skills in the first language of older individuals who are bilinguals, therefore, can be attributed to the typical processes accompanying older age, the typical processes accompanying first-language attrition in bilingual contexts, or both. The challenge, then, in understanding how lexical skills change in bilingual older individuals, lies in dissociating these processes. This paper addresses the difficulty of teasing apart the effects of ageing and attrition in older bilinguals and proposes some solutions. It presents preliminary results from a study of lexical processing in bilingual younger and older individuals. Processing differences were found for the older bilingual participants in their first language (L1), but not in their second language (L2). It is concluded that the lexical behaviour found for older bilinguals in this study can be attributed to L1 attrition and not to processes of ageing. These findings are discussed in the context of previous reports concerning changes in lexical skills associated with typical ageing and those associated with bilingual L1 attrition.

Keywords

Ageing; bilingual; lexical attrition; compound words; lexical decision

Introduction

Older individuals who use more than one language are vulnerable to two possible concomitant processes: L1 changes due to ageing and L1 attrition due to L2 use. In the lexical domain, word-retrieval difficulties have been associated with language changes accompanying healthy ageing (e.g. Au, Joun, Nicholas, Obler, Kass, & Albert, 1995; Connor, Spiro, Obler, & Albert, 2004) as well as with decreased L1 proficiency in the

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context of regular use of L2 (e.g. Olshtain & Barzilay, 1991; Köpke, 2002). Whereas age-related changes have been reported for lexical production but not for lexical perception (e.g. Burke, 1997; Goral, Spiro, Albert, Obler, & Connor, 2007), L1 attrition has been associated with changes in both lexical production and lexical perception (e.g. Köpke, 2004). The degree to which attrition-related changes are the result of performance limitations or alteration of the linguistic system itself is still a matter of debate (e.g. Seliger & Vago, 1991; Köpke, 2002; Cook, 2003).

When one considers age-related changes, there is no *a-priori* reason to expect that ageing processes should not affect both languages of bilingual older adults. Therefore, age-related lexical changes, if evident, are expected for both languages. To test this hypothesis, one can examine the lexical skills of both the first and second languages of older bilingual individuals. However, as researchers who study phenomena of bilingualism know, observed lexical behaviour might be affected by a number of additional variables, such as degree of language use and language proficiency. Such factors can yield differential effects in the two languages of the older bilinguals as they can in younger bilinguals. By contrast, changes in lexical skills associated with L1 attrition are, by definition, expected to affect predominantly the first language. Yet, here, too, the consideration of language use and additional variables is crucial, especially when performance in the two languages is compared.

The challenge, therefore, is to differentiate these processes that might influence lexical performance. That is, one needs to determine to what extent lower lexical performance in L1 of older bilinguals is associated with age-related decline vs L1 attrition. Separating the two processes may be achieved by comparing changes in lexical performance in both L2 and L1, while considering degree of language proficiency and use. If older bilinguals maintain high proficiency and use in both their languages, lexical changes, if found in both languages, cannot be interpreted as solely the result of L1 attrition. Changes in L1 only, by contrast, may provide evidence for L1 attrition rather than age-related change. Similarly, greater change in L2 in the presence of maintenance of L1 might be associated with age-related change. A second way to dissociate between attrition and ageing effects is to compare younger and older bilinguals who are in similar situations vis-à-vis their language proficiency, exposure, and use. Lexical changes observed in both younger and older bilingual individuals are more likely to be the results of L1 attrition, whereas changes unique to the older individuals can be attributed to processes of ageing.

One fertile area of investigation is the process of lexical recognition, as measured by visual or verbal lexical-decision tasks. Whereas lexical-decision tasks have not been extensively used with bilinguals who experience L1 attrition, the differences in the findings for lexical perception in older adults and in bilinguals can be employed in the comparison between age-related and L1 attrition-related changes. The research evidence available to date leads one to predict that, considering the extensive discussion on cognitive slowing associated with older age (e.g. See & Ryan, 1995; Salthouse, 2000), older adults will demonstrate slower response times in lexical-decision tasks than will younger adults. By contrast, they are not expected to demonstrate qualitative differences in their performance (see Discussion section).

To date, the study of language changes in ageing has yielded little data from non-monolingual individuals (e.g. Hernandez & Kohnert, 1999). Moreover, as has been discussed by scholars of bilingualism (e.g. Albert & Obler, 1978; Grosjean, 1998), it is difficult to compare bilinguals and monolinguals and might be inappropriate to use monolingual norms in studies of bilinguals. Testing bilingual participants in both their languages has demonstrated not only that language proficiency affects levels of performance, but also that the mean scores obtained for bilingual participants in each of their languages separately may differ from those obtained for monolingual individuals. For

example, bilingual adult speakers have been found to name fewer pictures correctly and generate fewer words on list-generation tasks in each of their languages than expected on the basis of monolingual norms (e.g. Kohnert, Hernandez, & Bates, 1998; Hernandez & Kohnert, 1999); of course, the combined scores in both languages may exceed those of monolinguals. To learn more about the association and dissociation of age-related and attrition-related changes, one must compare performance among bilinguals across the adult lifespan.

The approach in this study was to examine the performance of older and younger bilinguals in a primed decision task in which compound words served as the primary real-word targets. As is discussed in greater detail below, these compound words were presented under three priming conditions—one in which the compound target is preceded by its initial morphological constituent ('sand' → 'sandbox'), one in which the compound target is preceded by its final morphological constituent ('box' → 'sandbox'), and a neutral prime condition in which the compound is preceded by an unrelated simple word ('table' → 'sandbox'). Compound words are of particular use because they permit one to get beyond the simplest, often high-frequency monomorphemic words to test lexical organization and processing of complex words without entering the arena of contrastive morphosyntax. Furthermore, this experimental paradigm enabled a relatively efficient means of examining a number of aspects of lexical processing performance across bilingual age groups and across languages.

The first of these aspects is simply the speed and accuracy with which compound words are recognized in the bilingual's two languages. Here the focus is on the neutral primed condition, in which one has the opportunity to assess how quickly and accurately compound words in Hebrew and English are processed. The two morphologically primed conditions provide an additional measure of the extent to which compound word recognition is facilitated by prior presentation of their morphological elements. Studies of constituent-priming effects in compound-word processing in monolingual young adults (e.g. Kehayia, Jarema, Tsapkini, Perlak, Ralli, & Kadzielawa, 1999, in Polish and in Greek; Sandra, 1990, in English; the authors are unaware of priming experiments with compound words in Hebrew) have demonstrated that, as one might expect, when participants are exposed to the first or the second constituent of the target compound, their response latencies to the compound word are shorter than when they are presented with an unrelated (non-compound) word as the prime. These priming effects have been attributed to morphological processing, consistent with decomposition processes during complex-word recognition. Such priming effects are valuable because they can be construed as a measure of linkage strength within the lexical system. It is expected, for example, that bilingual speakers living in an L2 environment will be measurably slower in their lexical processing speed, perhaps simply because they are not called upon to process L1 words in real time as often as are speakers living in the L1 environment. However, what about connections within the L1 system itself? It is expected that even though speakers living in Israel will be significantly faster at judging the lexicality of compound words, that speed will be significantly increased by prior presentation of morphological constituents (see, for example, Libben and Jarema (2006) for a discussion of the locus of compound constituent priming effects). Of considerable interest in the investigation of qualitative changes that may be associated with language attrition in bilinguals is the extent to which changes are seen in the patterns of constituent priming among age groups.

It should be noted at this point that in the assessment of constituent-priming effects for English and Hebrew compound words, it is essential that facilitation for both the first constituent and second constituent be measured. The reason for this is that, although Hebrew and English compounding are relatively similar (given the otherwise substantial differences

in their morphological systems), they differ systematically in terms of which morphological element functions as the semantic head of the word and gives the compound its lexical category. So, for example, although both Hebrew and English have a word for ‘sandbox’ that is a compound and is composed of the morphological constituents ‘sand’ and ‘box’, in English the correct meaning requires that ‘sand’ be the first element and ‘box’ be the second. In Hebrew, obtaining the identical meaning requires that the elements be reversed, yielding the sequence "ארגז חול" (‘argaz chol’ = boxsand).

For the purpose of the present study, data were collected from older and younger bilingual speakers who live in their L2 environment and from bilinguals who live in their L1 environment. A compound recognition task was employed with the goal of dissociating ageing and attrition effects in lexical-perception skills of older bilingual adults.

Methods

Participants

Data were collected from 84 Hebrew-English bilingual speakers. All participants were native speakers of Hebrew with English as their second language. This study defines *native speakers* as those individuals who have acquired their L1 from birth or by age 5. Despite considerable disagreement in the literature about the role of age of exposure in attainment of native-like proficiency (e.g. Birdsong, 2005), most scholars agree that individuals who acquire a language in the first years of life and live in an environment in which that language is the majority language, become dominant in that language (e.g. Flege, Yeni-Komshian, & Liu, 1999; Jia, Aaronson, & Wu, 2002). Three participant groups were recruited: 12 Hebrew-English bilinguals living in and around NYC whose ages ranged from 55–64 (NY-older), 37 younger Hebrew-English bilinguals living in and around NYC whose ages ranged from 19–38 (NY-younger), and 35 Hebrew-English bilinguals living in Israel (Israel) whose ages ranged from 18–40. The groups did not differ in their education levels or handedness.¹ All participants were judged by the examiner to be healthy with no cognitive decline and reported no vision difficulty. Formal tests of vision or cognitive performance were not conducted due to time constraints. The participants in the NY-groups arrived in the US after age 18 and had been living in the US for 1 month or longer; the participants in the NY-older group had been living in the US, on average, significantly longer (29.7 years) than those in the younger group (4.2 years): $t(47) = -11.03, p < .001$. Participants in the Israel group had not lived in an English-speaking country. All participants reported that L1 was their dominant language and they all had learned English at school, in formal settings; their L2 proficiency varied. Participants living in NYC reported overall higher proficiency in their L2 than those living in Israel (see Discussion section for proficiency levels of the younger and older bilinguals living in NYC) as well as more frequent L2 use. Table I presents demographic information for the three participant groups.

Tasks and procedures

All participants completed a lexical-decision task (LDT) in L1 and in L2 in which the experimental conditions consisted of constituent priming for compound words. For each language, a list of 96 target items was presented to participants in a random order. The stimulus list comprised 24 compounds, 24 pseudo-compounds, 24 single words, and 24 pseudo-single words. The pseudo-compounds were made of two real words but did not exist as compounds in the language. The pseudo-single words were generated by altering one or two phonemes of a real word. Each target word was preceded by a prime word. For the

¹Whereas most participants were right-handed individuals, ten individuals who reported being left-handed were included. Their distribution across the three participant groups was comparable (about 10% of each group).

compound and the pseudo-compound targets, three types of primes were included: the first constituent of the target compound (C1), the second constituent of the target compound (C2), and an unrelated word. For the single words and pseudo-words, repeated and unrelated primes were included (see examples in Table II). Three lists were generated such that each participant saw each target only once, with one prime type.²

Each person was tested individually, seated in front of a Macintosh iBook. After signing the informed consent form (in English), the experimenter—a Hebrew-English bilingual speaker, reviewed the task with the participant (in Hebrew). In order to obtain L1 data prior to any potential effects of L2 processing,³ all the participants first completed a LDT in their L1, Hebrew, in which all prime and target words were Hebrew items. They then completed a second LDT, in their L2, English, in which all primes and targets were English items. Each language block took about 10 minutes.⁴ In addition, the participants were asked to fill in a detailed language history and use questionnaire. They were reimbursed for their time.

In each block, a fixation point appeared on the screen for 100 ms, the prime word was then presented for 100 ms, followed by the target word that remained on the screen until a response was made. Participants were instructed to press one key with their right hand to indicate ‘word’ and another key with their left hand to indicate ‘non-word’. The two keys were marked on the keyboard (yes/no). Before the beginning of each block, the instructions appeared on the screen, in the respective target language, followed by six practice items. If the participant had no questions, the experiment began. The practice items as well as the two first items in each block were discarded from the analysis.

Analysis

Percentage accuracy was tabulated for each participant in each condition in each experiment. Response times (RTs) of correct responses were tabulated and means and standard deviations were calculated. For each participant, responses longer than 3 seconds were removed; these typically represent outliers (including cases in which participants were inattentive or distracted from the task). In addition, responses that were over 2 SD above the participant’s mean were replaced by that value, calculated for each participant across ‘yes’ and ‘no’ response conditions separately. Between 1% and 5% of the observations were removed in Hebrew L1 and between 5% and 10% of the observations were removed in English L2; between 0% and 1% of the observations were replaced in Hebrew L1 and between 1% and 5% of the observations were replaced in English L2.

Results

Within-Hebrew primed LDT

Response times—A repeated-measures ANOVA with Priming Condition (3 levels: C1, C2, unrelated) as a within-subject variable and Participant Group (3 levels: Israel, NY-younger, NY-older) as a between-subjects variable revealed a significant main effect of Priming Condition:⁵ $F(2,79) = 10.4, p < .001$, and a significant main effect of Group: $F(2,79)$

²For the English lists, compound and single words were selected that were judged to be familiar to native speakers of Hebrew who are L2 users of English. Word length (in letters) and written word frequency (from CELEX) of the primes and targets in the various conditions were not equivalent across all the lists. Hebrew word frequency was not available for many of the Hebrew items. The authors plan to obtain frequency ratings from bilingual participants and revisit the word frequency distributions across the two LDTs.

³One of the research questions of the larger study, not discussed in details in the present paper, was to compare and contrast the pattern of constituent priming in Hebrew and in English, in an attempt to dissociate the roles of the first constituent, the head of the compound, and the compound modifier. For that reason, it was important to obtain the data from the Hebrew only experiment first.

⁴The two LDTs reported here were part of a larger session that included four LDTs as well as a naming test for the older participants and a translation-judgement task for the NY-younger group. These results are not reported in the current paper.

⁵Only by-subject analyses are reported here.

= 14.1, $p < .001$. There was no significant interaction between Condition and Group ($p > .1$). Planned comparisons revealed that the NY-older group was significantly slower than the NY-younger group: $t(43) = -2.14$, $p = .037$, and that the Israel group was faster than both the NY-younger group: $t(67) = 3.3$, $p < .01$ and the NY-older group: $t(46) = 3.9$, $p < .001$. Response times in the three priming conditions for the three participant groups are presented in Figure 1.

The Israel group showed a main effect of Condition: $F(2,34) = 16.5$, $p < .001$. The C1 priming condition yielded faster RTs than the unrelated priming condition: $t(34) = -5.5$, $p < .001$, as did the C2 priming condition: $t(34) = -4.3$, $p < .001$, and there was no difference between C1 and C2 priming effects: $t(34) = -1.4$, $p = .17$. The NY-younger group also showed a main effect of Condition: $F(2,32) = 10.9$, $p < .001$. Here, too, priming from both C1 and C2 differed significantly from the unrelated priming condition: C1 vs unrelated: $t(32) = -4.0$, $p < .001$, C2 vs unrelated: $t(32) = -4.2$, $p < .001$, and there was no difference between C1 and C2 priming $t(32) = -.96$, $p = .34$. By contrast, the NY-older group did not show a significant main effect of Priming Condition: $F(2,11) = .46$, $p = .64$. It should be noted, however, that the small number of participants in this group may have prevented the difference from yielding statistical significance. Examination of the pattern of RTs obtained for this group revealed that the unrelated priming condition yielded the longest RTs (as it did for the two other participant groups) but that there was great variability in performance.

Accuracy—The percentages of accurate responses were high overall (ranging from 93% to 97% for all groups). There was no significant main effect of Priming Condition: $F(2,84) = .45$, $p = .64$, nor of Group: $F(2,84) = 1.17$, $p = .18$, nor was there an interaction between the two variables: $F(4,84) = .19$, $p = .95$.

The results of the within-Hebrew LDT revealed that the older bilingual group was slower than the younger groups and only they did not show significant constituent-priming effects in their response times to compound words in Hebrew. There were no significant differences in accuracy rates among the three groups, nor among the three priming conditions.

Within-English primed LDT

Response times—A repeated-measures ANOVA with Priming Condition (3 levels: C1, C2, unrelated) as a within-subject variable and participant Group (3 levels: Israel, NY-younger, NY-older) as a between-subject variable revealed a significant main effect of Priming Condition: $F(2,72) = 6.21$, $p = .003$. The main effect of Group approached significance: $F(2,72) = 2.53$, $p = .087$, and there was no significant interaction (see Figure 2). Planned comparisons revealed that the Israel group was slower than the NY-younger group in both constituent-priming conditions: for C1, $t(61) = 1.98$, $p = .05$, for C2, $t(61) = 2.17$, $p = .03$, and the difference approached significance in the unrelated condition: $t(61) = 1.72$, $p = .089$. The difference between the Israel group and the NY-older group was not significant for C1: $t(39) = 1.33$, $p = .19$, and unrelated: $t(39) = .75$, $p = .46$ priming conditions but approached significance for C2 priming: $t(39) = 1.82$, $p = .07$.

Whereas the Israel group did not show a significant constituent-priming effect in L2: $F(2,11) = .99$, $p = .37$, the two NY groups did. The NY-younger demonstrated a significant Condition effect: $F(2,33) = 4.05$, $p = .02$, with both constituents yielding significantly faster RTs than the unrelated priming condition: for C1, $t(33) = -2.7$, $p < .01$, for C2, $t(33) = -2.6$, $p = .03$, and with no difference between them: $t(33) = .59$, $p = .56$. For the NY-older group, the effect of Priming Condition showed a trend toward significance: $F(2,11) = 2.56$, $p = .09$. Only the C2 priming condition was significantly different from the unrelated condition: $t(11) = -2.58$, $p = .026$, but C1 and C2 did not differ significantly.

Accuracy—Overall accuracy yielded a significant main effect of Group: $F(2,72) = 13.25$, $p < .001$, but no main effect of Condition: $F(2,72) = .29$, $p = .74$. When the three groups were compared, the Israel group was found to be less accurate in all priming conditions for English words than the NY-younger group: for C1 priming, $t(61) = -2.65$, $p = .01$, for C2 priming: $t(61) = -3.55$, $p < .001$, and for unrelated priming, $t(61) = -2.66$, $p < .01$, as well as than the NY-older group: for C1 priming, $t(39) = -3.17$, $p < .01$, for C2 priming, $t(39) = -3.72$, $p < .001$, and for unrelated priming, $t(39) = -2.85$, $p < .01$.

The results of the within-English LDT thus revealed that the older bilingual group was not slower nor less accurate than the younger groups. The Israel group was slower and less accurate than the NY groups and did not show significant constituent-priming effects in their response times to compound words in English.

In addition, when the ratio of RTs in the two languages in each group were examined, it was observed that the Israel group had longer RTs in L2 than in L1 (with a ratio of 1.60–1.68) and the NY-young group showed a difference, albeit smaller, in the same direction (1.23–1.25). The ratio for the NY-old group, by contrast, was close to 1 (1.07–1.12), indicating almost comparable RTs in the two languages of the older participants (see Figure 3).

Discussion

This study set out to compare and contrast lexical processing in L1 and L2 of older and younger bilingual speakers who had lived in their L2 environment. It was found that whereas the older adults had longer overall RTs in L1 than their younger peers, they did not show slower RTs than the younger group in L2 processing. Because one did not find overall longer RTs for the older than the younger adults, one can conclude that the longer RTs of the older participants in Hebrew are not likely due to overall age-related slowing. Consistent with this finding, there was no significant correlation between performance on English compounds and age (e.g. age and RT in the unrelated priming condition: $r = .14$, $p = .25$), whereas the correlation between Hebrew RTs and age was significant (e.g. for the unrelated priming condition: $r = .27$, $p = .01$).

This difference between L1 and L2 processing in the older group as compared to the younger group could be attributed to two (potentially related) processes: L1 attrition and increased L2 proficiency. As the English performance of the participants living in Israel (shown in Figure 3) indicates, lesser lexical processing ability is associated with increases in overall response time and a reduction of constituent priming effects. The reason for the reduction of constituent priming effects is that only a relatively high-functioning lexical system can make use of constituent information to activate a morphological family (of which the target compound is a member). Therefore, one can rule out L2 proficiency differences as the reason for the differences between the younger and the older groups for two reasons: First, the two NY groups did not differ in baseline performance on the lexical decision for English single words (RT: $t(44) = -.08$, $p = .93$; Accuracy: $t(44) = -.61$, $p = .55$). Second, the two groups showed the same pattern of constituent priming in English. This commonality of priming effects is consistent with the view that the older and younger adults are functioning in the same manner in their second language.

The longer RTs in L1 obtained by the older participants, therefore, appear to be due to processes of attrition in L1. Moreover, longer RTs were found in Hebrew for both the younger and older NY groups as compared to their peers living in Israel. This can be interpreted as L1 changes in the two NY groups. Yet the older NY group was slower than the younger NY group. The older individuals, on average, had been living in the US for longer periods of time than the younger group and length of stay in the US correlated

significantly with RT performance in L1 (r values ranged from .52–.62, $p < .001$). In addition, the ratio of RTs in L1 and L2 for the NY groups was close to 1 (as compared to close to 2 in the Israel group), indicating that their proficiency in the two languages approached comparable levels, which was particularly true for the NY-older group.

It is considered noteworthy that significant constituent priming effects were seen for all group-by-language combinations except for two: the participants living in Israel responding to English stimuli and the NY-older group responding to Hebrew stimuli. In both cases, this was interpreted to indicate reduced lexical proficiency. In the case of the English processing of the participants living in Israel, it is associated with incomplete acquisition of the English system. In the case of the Hebrew processing of the NY-older group, it is associated with attrition of the Hebrew system.

Thus, in the authors' view, these findings support the interpretation that L1 attrition is at the root of the results obtained for the NY-older group. Still stronger evidence might be found when comparing younger and older participants who have been living in their L2 environment for equivalent periods of time. This study was unable to conduct this comparison. Yet, by comparing and contrasting the performance on L1 and L2 among older and younger individuals, a picture emerges in which real changes in L1 lexical ability are seen among older bilinguals. These changes cannot be explained simply by positing general slowing of processing as a result of age, at least for this younger-old group of bilinguals (the older participants were rather young [55–64 years of age]; age-related changes on this task might be found for individuals in their 70s or 80s).

Lexical skills in monolingual ageing

How do the current findings compare to those obtained previously with monolingual older adults? Lexical skills have been reported to present difficulty for monolingual individuals in older age. Most of these findings concern lexical retrieval in production, not perception. Research studies have demonstrated that in laboratory naming tests, older adults produce target names of objects, actions, and people less often than younger adults (e.g. Borod, Goodglass, & Kaplan, 1980; Kaplan, Goodglass, & Weintraub, 1983; Nicholas, Obler, Albert, & Goodglass, 1985; Goulet, Ska, & Kahn, 1994; Au et al., 1995; Ramsay, Nicholas, Au, Obler, & Albert, 1999; Barresi, Nicholas, Connor, Obler, & Albert, 2000; MacKay, Connor, Albert, & Obler, 2002; Connor et al., 2004). These findings are also consistent with older adults' reports of having difficulty with naming in their daily life.

By contrast, vocabulary knowledge and word-recognition ability typically evidence no change (or even improvement) across the adult lifespan (e.g. Botwinick, 1977; Obler & Albert, 1984; Béland & Lecours, 1990; Wingfield & Stine-Morrow, 2000). Older individuals continue to acquire new words as the world around them changes. Furthermore, they are able to recognize words they know as accurately as younger individuals do, when no naming-production demands are imposed. This is true for vocabulary tasks that test word comprehension (e.g. Botwinick & Storandt, 1974; Verhaeghen, 2003; Goral et al., 2007). Similarly, tests of lexical decision have shown that older adults, while slower, are as accurate as younger participants (e.g. Bowles & Poon, 1985; Burke, White, & Diaz, 1987). When priming effects have been examined in lexical-decision tasks, older adults appear to show greater semantic priming effects than do younger adults; however, the interpretation of this finding has remained controversial (Lavar & Burke, 1993; Bowles, 1994).

These findings are consistent with those that show little lexical perception change in the younger range of older age. This study did not find the slower RTs often associated with older age across the two languages of the participants; instead, it found slower RTs in their L1 only. The selective effect in L1 is attributed to processes of L1 attrition due to persistent

use of L2; alternatively, one can argue that age-related cognitive slowing affects L1 and L2 differentially. This latter assumption, however, would be inconsistent with the well documented finding that highly automatic skills and those that are learned early in life are largely age invariant (e.g. Salthouse, 1985; Schaie, 1994). Furthermore, the magnitude of the priming effects found in the current study did not appear to differ for younger and older participants (the magnitude of RT priming in Hebrew and in English did not differ significantly between the two NY groups). Additional data and analyses are needed to further test magnitude difference in constituent priming in older age.

Lexical skills in bilinguals who experience L1 attrition

How do these findings compare with those that have been reported for first-language attrition? Research studies of L1 attrition in bilinguals have focused predominantly on language changes that occur in the first language of bilinguals, initially paying little attention to L2 skills or to mutual effects between the two languages. L1 changes may occur due to the influence of L2 on L1, the reduced use of L1 accompanying the increasing use of L2, or both. Researchers have demonstrated that lexical-retrieval during language production is vulnerable to the processes of attrition (e.g. Obler, 1982; Magiste, 1986; Boyd, 1993; de Bot, 1996; Nakuma, 1997; Hansen, 1999; Hulsen, de Bot, & Weltens, 2002; Köpke, 2002). In contrast to the studies of monolingual ageing, picture-naming tests have been less commonly employed in studies of L1 attrition. Rather, more- and less-constrained conversations have been used to examine L1 attrition (e.g. a story-telling task, Olshtain & Barzilay, 1991), suggesting, for example, that in early stages of L1 attrition, fewer lexical items are accessible for retrieval during language production and that, while basic meaning is retained, more specific selections are less available.

Additional studies of language attrition have addressed issues of L1 lexical attrition by analysing patterns of code switching and lexical borrowing and assessed phonological, morphological, and sociolinguistic aspects of these phenomena. Among those, Boyd (1993) has analysed the use of L2 during L1 production in bilinguals with Finnish or English L1 living in Sweden; Cohen (1989) has documented the attrition of Portuguese, the third language of a childhood Hebrew-English bilingual; and Turian and Altenberg (1991) have demonstrated the attrition of Russian in a Russian-English childhood bilingual. These studies have demonstrated that bilinguals living in their L2 environment experience increasing use of words from the non-target language (L2) in place of L1 targets.

Fewer investigations have focused on lexical perception in L1 attrition (Segalowitz, 1991; Green, 2000). Segalowitz (1991) has asked whether increased proficiency in L2 necessarily leads to decreased automaticity in L1. He employed a primed lexical-decision task and compared response times of more- and less-proficient young adult English-French bilinguals in more- and less-automatic priming conditions. His findings demonstrated that highly proficient bilinguals were slower to respond to words in their L1 than were less proficient bilinguals. These findings suggest reduced recognition-speed in L1 with increased L2 skills.⁶ These findings are consistent with those of Segalowitz in that longer L1 RTs were found for bilinguals living in their L2 environment who had higher L2 proficiency than those living in their L1 environment. Moreover, increased RTs and increased variability in response latencies associated with L1 attrition were found in the NY-older group as compared to the NY-younger group, even though the L2 proficiency levels did not differ between the two NY groups.⁷

⁶Segalowitz (1991) concluded that whereas recognition speed for L1 decreased with increased L2 proficiency, there was little evidence for differential automatic L1 processing of more- or less-proficient bilinguals.

Furthermore, studies of language attrition have addressed the question of whether the difficulties reported for bilinguals who experience L1 attrition reflect changes of language representation or are the results of retrieval failure (e.g. Seliger & Vago, 1991; de Bot & Weltens, 1995; de Bot & Stoessel, 2000), yet, this remains an open question.

Future directions

The present study began to look at lexical recognition in the L1 and L2 of older bilingual individuals. Compound words were selected as target items and constituent priming as the target lexical process. This permits one to examine word recognition in the two languages of bilingual speakers. Specifically, the two languages of these participants contain compound words; in addition, they share certain compounding processes and differ on others (e.g. Goral, Libben, Obler, & Jarema, 2005; Goral, Libben, Baayen, & Jarema, in preparation). Similar and different aspects of the target stimuli in the two languages can, it is argued, elucidate the mutual influence between the lexicons of the two languages of bilinguals. Detailed discussion of compound representation and processing is of course beyond the scope of this paper (see Sandra, 1990; Libben, 1998; Libben, Gibson, Yoon, & Sandra, 2003). Further analyses of the types of errors made by the younger and older participants and of evidence for transfer errors in both directions (from L1 to L2 as well as from L2 to L1) as well as additional studies of other aspects of lexical processing in bilingual speakers across the adult lifespan are fruitful directions for future investigation. Clearly, language use influences these processes; comparisons of younger and older groups living in both L1 and L2 environments would be useful as well.

Conclusion

The contribution of processes of age-related change and attrition-related change can be dissociated by examining performance of younger and older bilingual adults in both their languages in light of what is presently known about the similarities and differences of these processes (Goral, 2004). Studying language skills of older individuals who use more than one language contributes to one's understanding of age-related language changes in the complex context and the varying factors that influence language processing in bilingualism.

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⁷The authors were surprised by the large variance found for the NY-older group in their RTs in L1, as compared to the younger group. Of course, there is always a correlation between response latency and variance size as well as between the group size and the variance size. Moreover, large variance has been reported previously for older participants on many tasks (e.g. Christensen, Mackinnon, Jorm, Henderson, Scott, & Korten, 1994), but the variance in the older group's L1 RTs appears particularly large as compared to their variance in their L2 RTs.

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Figure 1. Response times (in ms) to Hebrew words in three priming conditions for three groups of Hebrew L1 speakers. Error bars represent one standard error above and below the mean.

Figure 2. Response times (in ms) to English words in three priming conditions for three groups of Hebrew L1 speakers. Error bars represent one standard error above and below the mean.

Figure 3.
L1/L2 ratio of response times in the three priming conditions for three groups of Hebrew L1 speakers.

Table 1

Demographic details.

	<i>n</i>	Age		Education		Length of stay in the US	
		<i>M</i> (SD)	Range	<i>M</i> (SD)	Range	<i>M</i> (SD)	Range
NY-Old	12	58.9 (2.5)	55–64	15.2 (3.2)	8–19	29.7 (12.0)	17–59
NY-Young	37	27.8 (5.1)	19–38	15.3 (2.8)	12–23	4.2 (4.4)	.01–19
Israel	31	26.6 (4.9)	18–40	14.6 (1.9)	12–18	N/A	N/A

Table II

Examples of stimuli.

	Real words		Pseudo-words	
	Prime	Target	Prime	Target
Hebrew (L1)				
C1	סכין	סכין גילוח	דבש	דבש גיהוץ
C2	גילוח	סכין גילוח	גיהוץ	דבש גיהוץ
Unrelated	חומס	סכין גילוח	פקיד	דבש גיהוץ
Repeated	מארכת	מארכת	גביע	חזודה
Unrelated	עלילה	מארכת	גביע	חזודה
English (L2)				
C1	wind	windmill	mirror	mirrorbird
C2	mill	windmill	bird	mirrorbird
Unrelated	band	windmill	clay	mirrorbird
Repeated	vegetable	vegetable	taste	sposque
Unrelated	closet	vegetable	taste	sposque