Attentional switching in the sequential flanker task: Age, location, and time course effects

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Received 15 February 2007; received in revised form 6 August 2007; accepted 8 August 2007
Available online 14 September 2007

Abstract

The sequential flanker task was developed to study sequential performance using methodology borrowed from studies of task switching. We investigated age differences in backward inhibition [BI: Mayr, U., & Keele, S. W. (2000). Changing internal constraints on action: The role of backward inhibition. Journal of Experimental Psychology: General, 129, 4–26] during a sequential category search task. Participants learned four animal categories in a fixed order, and then searched for exemplars from those categories in runs of mis-ordered exemplars. Across three experiments, we observed robust BI facilitation effects. However, the magnitude of BI effects did not differ across age groups. This age-invariance held despite manipulations of distractibility (Experiment 2), and interstimulus interval (Experiment 3), suggesting that BI processes may be relatively automatic and obligatory in the context of sequential tasks. The findings are discussed in terms of the attentional mechanisms that underlie task set switching and sequential performance.

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PsycINFO classification: 2820

Keywords: Sequential performance; Inhibition; Executive control; Task set switching

1. Introduction

Several areas of research converge to suggest that there may be an age-related decline in sequential performance, which is essential for many activities of daily living (e.g., bathing, cooking). Sequential performance, defined here as the completion of multiple steps in fixed order, may be supported by inhibitory mechanisms which prevent task repetitions and propel attention forward (e.g., Houghton & Tipper, 1996; Li, Lindenberger, Rünger, & Frensch, 2000). Similarly, the rapid transition from one task set to the next during task set switching has been hypothesized to involve backward inhibition (BI: Mayr & Keele, 2000; see also Arbuthnott & Frank, 2000; Arbuthnott & Woodward, 2002; Hübner, Dreisbach, Haider, & Kluwe, 2003). By this view, BI suppresses features relevant to the previous task set when a switch has occurred. Findings that show a moderate age-related decline in the efficiency of switching (e.g., Cepeda, Kramer, & Gonzalez de Sather, 2001; Kramer, Hahn, & Gopher, 1999; Kray, Li, & Lindenberger, 2002; Kray & Lindenberger, 2000; Mayr, 2001) and others that show declining inhibitory efficiency (e.g., for reviews, see Hasher, Zacks, & May, 1999; McDowd & Shaw, 2000) jointly suggest that age-related deficits in task set switching, and by extension, sequential performance, are attributable to declines in similar inhibitory processes.

Contrary to these findings, other researchers have shown age-equivalent inhibitory functioning in serial recall (Maylor & Henson, 2000) and task set switching (Mayr, 2001). Maylor, Schlaghecken, and Watson (2005) proposed that inhibitory processes involved in post-response output and serial behavior may be age-invariant. Given the small...
number of studies investigating this inhibitory situation, the purpose of the current research is to compare younger and older adults’ inhibitory efficiency during sequential transitions using a newly developed procedure, the sequential flanker task.

1.1. Task set switching and backward inhibition

Mayr and Keele (2000) proposed backward inhibition (BI) as a mechanism that suppresses task set characteristics once a new task set is invoked. This has been empirically tested by comparing different forms of task alternations (tasks A–B–A, vs. C–B–A) and finding a slowing in response latency when participants must return to a recently abandoned task set (i.e., task A in the first series). Mayr and Keele attribute this slowing to carry-over inhibition of Task A characteristics following a switch to Task B. In the second series however, responses to Task A should not be slowed because Task A has not recently been carried out. This resultant condition difference has been termed the BI effect, or alternating switch cost (Arbuthnott, 2005). Such effects have since been replicated using a variety of perceptual and semantic processing tasks (e.g., Arbuthnott, 2005; Arbuthnott & Frank, 2000; Mayr, 2001; Schuch & Koch, 2003).

While a growing number of studies have shown that BI can reduce the availability of a recently abandoned task set, Hübner and colleagues (2003) more directly demonstrated that BI can reduce interference from the inhibited task set. In their switching procedure, participants alternated between three decision tasks: consonant/vowel letters; odd/even digits; straight/curved symbols. Distractors in the form of flankers (Eriksen & Eriksen, 1974) from competing tasks were presented alongside the targets on a portion of trials. On BI trials, the flankers were related to the previous target task. For example, on Trial n−1, if participants saw the target “#”, a BI Trial n would be “&2&”, as compared to a control Trial n (“H2#”). In this context, BI is observed as a facilitation effect, where inhibition of task-relevant features on Trial n−1 is carried over into Trial n, and aids in ignoring the flankers (see also Dreisbach & Goschke, 2004).

In contrast to the originally reported BI effect which involves a slowing of responses (Mayr & Keele, 2000), Hübner’s finding of BI-related facilitation is more intuitively consistent with the notion that BI helps to facilitate smooth transitions between tasks. This methodological difference becomes relevant in considering comparisons of younger and older adults’ BI using a task switching procedure (Mayr, 2001, Expt. 1). Using three perceptual decision tasks, Mayr observed statistically equivalent BI effects in young and older adults, leading him to conclude that BI could be a low-level automatic mechanism that is spared by aging (Mayr, 2001; Mayr & Keele, 2000). Given the rarity of observing age-equivalent inhibitory efficiency (cf. Hartley & Kieley, 1995), it would be useful to evaluate the generalizability of Mayr’s (2001) findings with different procedures. Moreover, it is of interest to examine BI and aging using a procedure that measures BI efficiency as a performance benefit (Hübner et al., 2003) as opposed to a slow down (Mayr, 2001).

1.2. The sequential flanker task

By blending previous methods of studying sequential performance (Li et al., 2000) and BI in task set switching (Hübner et al., 2003), we developed the sequential flanker task (SFT), which incorporates endogenously driven transitions from one category to another. We used a four-category sequence with three exemplars in each category. Participants first learned the sequence order, and then used that sequence order when monitoring for category exemplars. We asked participants to respond “yes” to sequentially consistent targets and “no” otherwise. Similar to previous work (Hübner et al., 2003), stimuli were presented with or without flankers. We define a sequential transition trial (n−1) as one in which a category exemplar is found, a “yes” response is made, and the participant has then switched to searching for exemplars from the next category in the learned sequence. Trials following a sequential transition (n) were classified as either BI trials if targets on trial n−1 were from the same category as flankers on trial n, or control trials if there was no such relation.

In light of the large body of research on aging and declining inhibitory processes (Hasher et al., 1999; Zacks, Hasher, & Li, 2000), we made the prediction that older adults would show less efficient BI processes than young adults in the context of our SFT paradigm. Alternatively, if we were to replicate Mayr’s (2001) finding of age-equivalence in BI efficiency using a new methodology, our findings would extend and strengthen those results. Finding age-equivalent BI processes would also support Maylor’s contention that inhibitory processes associated with serial behavior and postoutput response suppression are age-invariant (Maylor & Henson, 2000; Maylor et al., 2005).

2. Experiment 1

To our knowledge, this experiment represents the first attempt to study age differences in BI efficiency within a sequential task context. We hypothesized that all participants would show significant BI effects following the transition from one sequential target to the next. Specifically, we should observe faster responses to trials with flankers from the same category as the target on the preceding trial, compared to trials with no such relationship (e.g., Hübner et al., 2003). Young adults were expected to produce larger BI effects than older adults, in keeping with previous research on aging and inhibition. We also tested the effect of flanker presence on SFT performance to assess the potential confound of age differences in flanker distractibility.
2.1. Method

2.1.1. Participants

Twenty younger (20–34 years) and 20 older adults (62–80 years) were recruited for this experiment. Younger adults were recruited through university poster and website advertisements. Older adults were recruited from the Montreal community through advertisements in local newspapers. All participants were screened for conditions resulting in impaired perceptual abilities, poor concentration, dizziness, or motoric difficulty. Five participants were excluded due to low accuracy (less than 70% correct) on unflanked trials. Nineteen younger (M = 23.2 years, SD = 3.4) and 16 older (M = 72.1 years, SD = 12.2) participants were subsequently considered for data analysis. Younger adults performed significantly better than older adults, t(32) = 4.52, p < 0.001, on the WAIS Digit-symbol substitution task (Wechsler, 1981), a measure of cognitive speed of processing (M_Y = 72.1, SD_Y = 12.2; M_O = 53.9, SD_O = 10.9), confirming the comparability of our samples vis à vis other aging studies.

2.1.2. Materials and design

The stimuli for the SFT consisted of 12 animal exemplars divided into four categories. The categories were arranged in increasing size order: Insects (fly, ant, mosquito), Birds (sparrow, crow, robin), Fish (salmon, trout, herring), and Large Wild Animals (elephant, giraffe, rhinoceros). These exemplars were chosen for their high normative frequency of usage (Battig & Montague, 1969). All stimuli were presented as words on a Macintosh G4 computer in yellow, 22 point Times New Roman font, and were presented in the center of the screen on a dark blue background. We followed the methodology of Shaw’s (1991) study of aging and flanker effects in terms of range of visual angle and viewing distance. On flanked trials, three words appeared in a column 2 cm high, and the spacing between them was kept constant. The viewing distance for all participants was between 30 and 60 cm from the computer, and was kept variable (i.e., we opted not to use a chin rest) to maximize the participants’ comfort. The SFT stimuli were created using SuperLab Pro for Macintosh. Responses were made on a Cedrus RB-610 response box.

Fig. 1 illustrates one run of trials and includes examples of BI and neutral trials, flanked and unflanked trials, sequential transition and no-transition trials. On flanked trials, the middle item appeared on the screen with one flanker word above and the same word below. On such trials, the flankers were never identical to the middle item, nor category-consistent with the middle item. On BI trials (e.g., Trial 2), the flanker category corresponded to the category of the middle item on the previous trial. On control trials (e.g., Trial 5), this successive target–flanker relationship was not present. Each word appeared an equal number of times as a flanker and a middle item. Orthogonal to the BI and flanker manipulations, the content of the middle item of each trial was varied in terms of the learned sequential order. The trials were organized in groupings, or runs. All runs contained the four targets and terminated after the fourth target exemplar was presented. A target was defined as an exemplar from the currently relevant category (i.e., a ‘yes’ item). A distractor was defined as an exemplar from any other category (i.e., a ‘no’ item). The average run length was eight trials, with a range of 6–10 trials. Between any two targets there could be a maximum of three distractors.

Eighty-seven percent of all trials contained flankers. Approximately half (51.6%) of all trials were sequential transition trials. Following transition trials (n – 1), 30.7% were BI trials and 69.3% were control trials. Following no-transition trials (n – 1), the breakdown was similar (38.4%, 61.6%, respectively).

2.2. Procedure

Testing took place within the Adult Development and Aging Laboratory at Concordia University. Participants gave their informed consent and completed a demographic questionnaire. They then completed a stimulus familiarization procedure in which participants were given four index cards with the category names on them and were asked to lay them out in the learned order. They then sorted 12 index cards with the exemplar names on them according to category. Participants completed this task twice before beginning the SFT. Following the SFT, participants were debriefed and given a Concordia University pen. Each session lasted approximately 90 min.

2.2.1. Sequential flanker task

In the SFT, participants were instructed to monitor for an instance of each category in the learned order while watching successive screens of flanked and unflanked stimuli. The stimuli were presented with an ISI of 2000 ms. Participants were asked to respond “YES” with their left index finger if the middle item was an exemplar of the category they were currently monitoring for, or “NO” with their right index finger otherwise. If the participant responded incorrectly to the stimulus, or did not respond within the designated time (error of omission), a feedback screen appeared and indicated which category they should now monitor for. Participants then had to press the “next” key to resume their performance. A blank screen was shown for 2000 ms between the end of one run and the beginning of the next run.

The task began with a practice block of eight runs. Participants then completed two experimental blocks with 47 runs in each, with 732 test trials in total. There was a short break between the two blocks at which time the Digit-symbol Substitution task was administered.

2.3. Results and discussion

The response latency data were trimmed at ±3 SDs, computed on the basis of each individual’s correct RT
distributions. We opted to use trimmed RTs in addition to dropping participants with low accuracy (see Participants) to exclude any data points that might be either too fast or slow to be representative of each individual’s performance. The analyses presented are based on median RTs and percentage error scores. Table 1 shows the RT and error data per age group and condition.

### 2.3.1. Backward inhibition

To examine the influence of age on BI magnitude, we compared young and older adults’ latency data. For the BI analyses, we only included trials that immediately followed a sequential transition (e.g., “An instance of Category 1 was just found, now look for an instance of Category 2”). BI trials were defined as those in which the flankers were categorically related to the target on the immediately previous trial; control trials were those in which there was no such relationship with the previous trial. Both trial types included a mixture of ‘yes’ and ‘no’ responses. An Age Group (young, older) × Trial Type (BI, control) mixed factorial ANOVA (analysis of variance) using latency data revealed a significant main effect of trial type, $\frac{\sigma}{(1,33)} = 9.34$, $p = 0.004$, $\eta^2 = 0.22$, such that responses on BI trials ($M = 677$ ms, $SEM = 13.8$) were faster than on control trials ($M = 693$, $SEM = 12.8$). Not surprisingly, the main effect of age group was significant, $\frac{\sigma}{(1,33)} = 28.38$, $p < 0.001$, $\eta^2 = 0.46$, such that young adults ($M = 616$ ms, $SEM = 17.6$) responded more quickly than older adults ($M = 755$ ms, $SEM = 19.2$). We also observed a marginally significant interaction of age group and trial type, $\frac{\sigma}{(1,33)} = 3.33$, $p = 0.077$, $\eta^2 = 0.09$. Post hoc contrasts revealed that this interaction was driven by a significant trial type effect for young adults, $t(19) = -3.86$, $p = 0.001$, and a non-significant effect for older adults, $p = 0.494$ (see Table 1).

<table>
<thead>
<tr>
<th>Trial type</th>
<th>BI</th>
<th>Neutral</th>
<th>Flanked</th>
<th>Unflanked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median RT (ms)</td>
<td>603</td>
<td>628</td>
<td>603</td>
<td>592</td>
</tr>
<tr>
<td>(n = 19)</td>
<td>(19)</td>
<td>(17)</td>
<td>(16)</td>
<td>(17)</td>
</tr>
<tr>
<td>Older</td>
<td>750</td>
<td>758</td>
<td>731</td>
<td>742</td>
</tr>
<tr>
<td>(n = 16)</td>
<td>(20)</td>
<td>(9)</td>
<td>(18)</td>
<td>(18)</td>
</tr>
<tr>
<td>Errors (%)</td>
<td>5.3</td>
<td>5.6</td>
<td>6.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Younger</td>
<td>(1.1)</td>
<td>(1.3)</td>
<td>(1.5)</td>
<td>(1.4)</td>
</tr>
<tr>
<td>(n = 19)</td>
<td>(1.3)</td>
<td>(1.4)</td>
<td>(1.5)</td>
<td>(1.4)</td>
</tr>
</tbody>
</table>

Fig. 1. Sequential flanker task stimuli for one run. Flanked trials (items 2, 4, 5) are intermixed with unflanked trials (1, 3, 6). Participants should respond “yes” to Trials 1, 2, 4, and 6. A BI trial is illustrated on Trial 2 because the flankers (mosquito) are from the same category as the target on the previous display, and because it follows a transition trial. Trials 4 and 5 are neutral control trials because there is no flanker–target relationship with the previous trials.
Using percent error scores and the same ANOVA design, we found non-significant effects of trial type, age group, and the two-way interaction (all $p$ > 0.10). We attribute these null effects to the low error rates produced by both age groups (overall $M$ = 5.8%, SEM = 0.84; see Table 1).

With the SFT design, we were also able to examine the rival hypothesis that the BI facilitation observed by Hübner et al. (2003) was due to category priming from Trial $n-1$ to $n$. To test this rival hypothesis, we compared the BI and control trials associated with transition trials and the analogous trials associated with non-transitions. According to Mayr and Keele’s (2000) definition of BI, we should only expect the inhibitory process to take effect after a task switch. Accordingly, we operationalized BI trials as occurring only after an endogenous switch to a new category (i.e., after a sequential transition). If BI facilitation were due to category priming, we should observe significant BI effects in both transition and non-transition trials. We analyzed the latency data using the same ANOVA design reported previously, plus an additional within-subjects switch factor. Subsequently, the interaction of trial type (BI, control) and switch (transition, no-transition) was very robust, $F(1,33) = 38.03, p < 0.001, \eta^2 = 0.54$ (see Fig. 2). The interaction was driven by the previously observed BI facilitation effects in the case of transition trials, and the reverse relationship in the case of no-transition trials. During no-transition trials, we assume that participants had not yet inhibited the relevant category exemplars (i.e., there was carry-over activation of the target category from Trial $n-1$ to $n$). These transition effect findings are in line with models of BI and task set switching (e.g., Arbuthnott, 2005; Arbuthnott & Woodward, 2002; Hübner et al., 2003; Mayr & Keele, 2000; Schuch & Koch, 2003), and suggest that BI facilitation is not due to category priming.

### 2.3.2. Flanker presence

To evaluate the effect of flanker presence on the SFT performance of young and older adults, we carried out Age Group (young, older) $\times$ Trial Type (flanked, unflanked) mixed factorial ANOVAs using correct median RT and percent error scores (see Table 1) using only control (non-BI) trials to avoid confounding the effects of other manipulations. For the latency analysis, we only observed a significant main effect of age group, $F(1,33) = 34.31, p < 0.001, \eta^2 = 0.51$, due to faster overall RTs for young adults ($M$ = 597 ms, SEM = 16.1) compared to older adults ($M$ = 737 ms, SEM = 17.5). The main effect of trial type was not significant ($p = 0.96$), although the interaction of trial type and age group was marginally significant, $F(1,33) = 3.96, p = 0.06, \eta^2 = 0.11$. Post hoc $t$-tests were conducted separately by age group and revealed non-significant trial type differences in each case ($p$ = 0.17 and 0.18 for YA and OA, respectively). Similarly, analysis of the percent error data for flanker and age effects revealed non-significant main effects and interactions ($p$ > 0.25). Condition means are shown in Table 1.

### 2.3.3. Summary

The current results provide the first evidence of BI effects during sequential performance using the sequential flanker task. We attribute this BI advantage to the utilization of inhibitory processes that aid in suppressing category-consistent flankers, similar to Hübner et al. (2003). We observed only marginal support for age-related decline in the BI (cf. Hasher & Zacks, 1988; Hasher et al., 1999). It
should be noted that we did not observe any evidence for age differences in the magnitude of BI in the error data, thus our interim conclusions with regard to aging and BI are somewhat ambiguous. Our results also support the contention that BI should only occur following a transition (Mayr & Keele, 2000). The flanker analyses revealed that neither age group was penalized by the presence of flankers, and importantly, that flanker effects did not differ across age groups. In the next experiment we aimed to increase the difficulty of the SFT and possibly observe a more robust interaction of age group and BI in both RT and error data.

3. Experiment 2

Our primary goal for this experiment was to further test the hypothesis that older adults would show smaller BI effects compared to young adults. We increased the distractibility of the flankers, given that in Experiment 1, flanker presence did not significantly affect SFT performance. A likely reason for this null finding was that targets (and flankers) were always presented in the same location (Cowan, 1988). Previous research demonstrates that it is easier to ignore visual distraction presented in predictable locations than in unpredictable locations, both for younger and older adults (e.g., Carlson, Hasher, Zacks, & Connelly, 1995; Li, Hasher, Jonas, Rahhal, & May, 1998). We therefore opted to randomly vary the spatial location of stimuli on one out of two blocks of test trials.

It is worth noting that although all participants in Experiment 1 were equally able to ignore the flanker words with minimal cost either in their response latency or error data, we were able to observe carry-over effects when there was a semantic relationship between targets and flankers on subsequent trials (i.e., the overall BI effect was robust in the RT data). Given this finding, it was of additional interest to examine the effects of increased distraction on the magnitude of BI effects, and possible interactions with age.

In sum, for Experiment 2, we expected that younger adults would show BI effects, as reflected in performance facilitation on sequential transition trials in which the target category on Trial \( n - 1 \) was the same as the flanker category on Trial \( n \). In contrast, we expected older adults to show diminished BI effects relative to the young adults. Additionally, we expected that flanker presence effects would be larger during unpredictable-location trials compared to predictable-location trials.

3.1. Method

3.1.1. Participants

Twenty younger (18–35 years) and 20 older adults (60–75 years) were recruited for this experiment. Data from two younger participants were excluded due to disproportionately slow response latencies relative to the young adults’ RT distribution, and two older adults’ data were excluded due to low performance accuracy (less than 70% for unflanked trials). Eighteen younger adults (\( M = 24.2 \) years, SD = 5.1) and 18 older adults (\( M = 67.4 \) years, SD = 6.4) were considered for data analyses. As shown in Experiment 1, younger adults performed significantly better than older adults, \( t(34) = 4.04, p < 0.001 \), on the Digit-symbol Substitution test (Wechsler, 1981), our measure of cognitive speed (\( M_Y = 71.8, \) SD = 10.8; \( M_O = 58.2, \) SD = 8.2). Recruitment techniques and exclusion criteria were the same as in Experiment 1. Participants were given $10.00 CND for their time and effort. Each session lasted approximately 90 min.

3.1.2. Materials, design, and procedure

All materials and instrumentation for the SFT and background measures (demographic questionnaire, WAIS Digit-symbol substitution) were identical to those used in Experiment 1. The present study differed from the previous experiment in that participants were given one block of trials in a predictable central location (as in Experiment 1) and one block of trials in which location varied. The variable location stimuli were either in the original location, or above or below, the original location of target and flanker configurations. We created the greatest spatial overlap possible, such that if the original flanker–target–flanker display hypothetically occupied Lines 2, 3, and 4; the “above” stimuli would occupy Lines 1, 2, and 3. Likewise, the “below” stimuli would occupy Lines 3, 4, and 5. Order of the two location conditions was counterbalanced across participants in each group. Each block of 47 runs was preceded by six practice trials of the appropriate type. The general procedures were identical to those described in Experiment 1.

3.2. Results and discussion

Methods used to trim and aggregate the data were the same as in Experiment 1, except that the \( z \)-score distributions used for data trimming were established for each location condition on a person-by-person basis. The latency and error data are shown in Table 2.

3.2.1. Backward inhibition

To examine the effects of age and stimulus location on BI, an Age Group (young, older) \( \times \) Trial Type (BI, control) \( \times \) Location (predictable, unpredictable) mixed factorial ANOVA was carried out using median correct RTs. A significant main effect of location was observed, \( F(1,34) = 5.41, p = 0.026, \eta^2 = 0.137 \), indicating that both younger and older adults responded more quickly when the stimuli were presented in predictable (\( M = 769 \) ms, SEM = 16.0) compared to unpredictable (\( M = 815 \) ms, SEM = 13.5) locations. We also observed a significant main effect of trial type, \( F(1,34) = 9.32, p = 0.004, \eta^2 = 0.22 \), due to faster responses on BI trials (\( M = 784 \) ms, SEM = 11.7) than on control trials (\( M = 800 \) ms, SEM = 10.7) overall. This was qualified by
Table 2
Experiment 2: Latency and error data (SEMs) by age group, trial type, and location type (predictable vs. unpredictable)

<table>
<thead>
<tr>
<th>Trial type</th>
<th>BI</th>
<th>Neutral</th>
<th>Flanked</th>
<th>Unflanked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Younger</td>
<td>670</td>
<td>724</td>
<td>703</td>
<td>737</td>
</tr>
<tr>
<td>Older</td>
<td>842</td>
<td>901</td>
<td>860</td>
<td>899</td>
</tr>
</tbody>
</table>

Errors (%)

| Younger    | 5.9   | 5.4     | 7.7    | 7.6      | 7.7   | 8.6      | 5.7   | 4.7      |
| (n = 18)   | (1.9) | (2.0)   | (2.7)  | (2.4)    | (2.6) | (2.9)    | (2.0) | (1.6)    |
| Older      | 11.3  | 10.3    | 14.4   | 14.0     | 12.1  | 12.9     | 9.1   | 8.1      |
| (n = 18)   | (1.9) | (2.0)   | (2.7)  | (2.4)    | (2.6) | (2.9)    | (2.0) | (1.6)    |

a marginal interaction of location and trial type, $F(1,34) = 3.31, p = 0.078, \eta^2 = 0.09$, which was driven by a significant trial type effect for predictable location trials, $t(39) = -2.66, p = 0.011$, and a non-significant trial type effect for unpredictable location trials, $p = 0.339$. Finally, a significant main effect of age group was observed, $F(1,34) = 58.29, p < 0.001, \eta^2 = 0.630$, due to faster response latencies overall for young adults ($M = 708$ ms, $\text{SEM} = 15.5$) compared to older adults ($M = 876$ ms, $\text{SEM} = 15.5$). All other interactions, notably including the age group \times trial type interaction, were non-significant (all $p > 0.10$).

BI effects were further examined using percent error scores in a mixed factorial ANOVA with age group, trial type, and location as factors. In this analysis, a marginally significant main effect of age group was observed, $F(1,34) = 3.90, p = 0.057, \eta^2 = 0.103$, due to lower error rates in the young ($M = 6.7%, \text{SEM} = 1.3$) than the older ($M = 12.5%, \text{SEM} = 2.1$) adults. We also observed a significant main effect of trial type, $F(1,34) = 12.93, p < 0.001, \eta^2 = 0.28$, such that across groups and conditions, participants produced fewer errors on BI trials ($M = 8.2%, \text{SEM} = 1.3$) than on control trials ($M = 10.9%, \text{SEM} = 1.7$). All other main effects and interactions were non-significant (all $p > 0.30$).

As in Experiment 1, we added a Switch factor to the previous ANOVA design to verify the assumption that BI effects should only be observed following transition trials. As with Experiment 1, the BI \times Switch interaction was very robust in the latency data, $F(1,34) = 27.16, p < 0.001, \eta^2 = 0.44$, thus again ruling out the rival hypothesis of category priming (see Fig. 2).

3.2.2. Flanker presence

The manipulation of stimulus location was expected to have its greatest effects on the magnitude of the flanker effect, given that visual selective attention must be used to ignore the flankers. To examine the effects of age and stimulus location on flanker effects as expressed in latency measures, we carried out a mixed factorial ANOVA using correct median RTs, with age group as a between-subjects factor; location and trial type as within-subjects factors. As in Experiment 1, only neutral non-BI trials were considered for the flanker presence analyses. These data are shown in Table 2. As predicted, we obtained a significant interaction of trial type and location, $F(1,34) = 8.72, p = 0.006, \eta^2 = 0.20$. Post hoc contrasts show that flanked trials were significantly slower than unflanked trials for the unpredictable location condition, $t(39) = -2.38, p = 0.023$, but not for the predictable location condition ($p = 0.21$). Not surprisingly, the age group main effect also proved significant, $F(1,34) = 51.89, p < 0.001, \eta^2 = 0.60$, due to shorter RTs for young adults ($M = 670$ ms, $\text{SEM} = 15.5$) than for older adults ($M = 827$ ms, $\text{SEM} = 15.5$). All other main effects and interactions were non-significant ($p > 0.18$).

A similar mixed-factorial ANOVA was carried out using the error data. Here, we found a significant main effect of trial type, $F(1,34) = 9.54, p = 0.004, \eta^2 = 0.22$, indicating that all participants made fewer errors during unflanked trials ($M = 6.9%, \text{SEM} = 1.2$) compared to flanked trials ($M = 10.3%, \text{SEM} = 1.5$). Similar to the RT analyses, this main effect was qualified by a significant interaction of trial type and location, $F(1,34) = 4.56, p = 0.040, \eta^2 = 0.12$. Bonferroni corrected ($\alpha = 0.025$) post hoc contrasts reveal that the interaction was driven by a significant flanker presence effect in the unpredictable location condition, $t(39) = 3.19, p = 0.003$, compared to a less significant flanker effect in the predictable location condition, $t(39) = 2.60, p = 0.014$. All other main effects and interactions were non-significant ($p > 0.64$).

3.2.3. Summary

The results of Experiment 2 replicate the BI main effect found in Experiment 1, and further show that in the RT data, the BI effect was attenuated by the increased attentional demands of the unpredictable location condition. As in Experiment 1, the error data were less sensitive than the RT measure to the effects of age, and now, location. Importantly, the present data revealed intact BI facilitation in both young and older adults, which was restricted to tri-
als following a sequential transition. The flanker analyses validated our manipulation of location predictability in Experiment 2, showing that all participants were more distracted by flankers when stimulus location was unpredictable. Similar to previous research on reading with distraction (Carlson et al., 1995; Li et al., 1998), we found that young and older adults were comparably disrupted by our manipulation of location predictability.

Our initial aim in Experiment 2 was to increase the selection demands of the SFT and potentially increase the robustness of the Age Group × BI interaction observed in Experiment 1. However, the results suggest that our manipulation had the opposite effect of abolishing the interaction. Given that the Age Group × Trial Type (BI effect) interaction proved only marginally significant for the RT data in Experiment 1, the majority of SFT findings thus far weigh in favor of age-equivalence in terms of BI effects, in line with Mayr’s (2001) findings using a task set switching paradigm. Our next experiment was designed to further probe this tentative conclusion of age equivalence in BI.

4. Experiment 3

In this experiment, we varied the pace of the SFT to evaluate the possibility that the time course of BI might differ between age groups (see Maylor et al., 2005, for similar arguments). Previous research on the BI effect (e.g., Arbuthnott & Frank, 2000; Hübner et al., 2003; Mayr & Keele, 2000) suggests that BI decays or dissipates over time, indicating an optimal time window for BI effects to be observed. Experiments 1 and 2 involved a fixed ISI of 2000 ms, which produced robust main effects of BI (RT data in Expt. 1; both RT and error data in Expt. 2). To accommodate performance limits in the older adults, and to examine the question of age interactions with BI, we opted not to decrease the ISI below 2000 ms and instead, systematically increased the ISI. If we were to find age-equivalent BI effects across all ISIs, we would have more comprehensive evidence of age-equivalent BI effects (e.g., Mayr, 2001).

4.1. Method

4.1.1. Participants

Twenty younger (18–35 years) and 20 older adults (60–75 years) were recruited for this experiment, in the same manner as in the previous experiments. Data from three older participants were excluded due to disproportionately low performance accuracy (less than 70% correct for unflankled trials). Consequently, 20 young adults \( (M = 22.0 \text{ years} \ SD = 3.0) \) and 17 older adults \( (M = 65.9 \text{ years} \ SD = 5.0) \) were considered for data analyses. As expected, younger adults performed significantly better, \( t(34) = 2.55, p = 0.016 \), on the Digit-symbol Substitution test (Wechsler, 1981), our background measure of cognitive speed \( (M_Y = 73.3, \ SD_Y = 9.80; \ M_O = 63.4, \ SD_O = 13.3) \). All participants were given $10.00 CND for their time and effort. Each session lasted approximately 90 min.

4.1.2. Materials, design, and procedure

Testing materials and apparatus were identical to those used in Experiments 1 and 2. Stimuli were always located in the center of the screen as in Experiment 1. The current experiment differed from previous designs in that the ISI was randomly varied across runs. The five possible time intervals were: 2000, 2250, 2500, 2750, and 3000 ms. Trials within the same run were assigned the same ISI so that successive BI trials would not be confounded by variations of ISI. The general procedures were the same as those used in the previous two experiments.

4.2. Results and discussion

Methods used to trim and aggregate the data were the same as in Experiments 1 and 2, except that the z-score distributions used for data trimming were computed per person and ISI condition. Table 3 shows RT and error data per age group and condition.

4.2.1. Backward inhibition

To evaluate the effects of ISI on possible age group differences in BI, we carried out a mixed factorial ANOVA with age group (young, older) as the between-subjects factor, and trial type (BI, control) and ISI (2000, 2250, 2500, 2750, 3000 ms) as within-subjects factors. The main effect of trial type proved significant, \( F(1,35) = 20.57, p < 0.001, \eta^2 = 0.370 \), due to shorter RTs on BI trials \( (M = 723 \text{ ms}, \ SEM = 13.7) \) compared to control trials \( (M = 756 \text{ ms}, \ SEM = 14.9) \). Notably, the interaction of trial type and age group was non-significant \( (p = 0.62) \), in line with the age-invariance in BI observed here (Expt. 2) and elsewhere (Mayr, 2001). The main effect of ISI proved significant, \( F(4, 32) = 8.61, p < 0.001, \eta^2 = 0.518 \). Polynomial contrasts indicated that the ISI function was quadratic in shape, \( F(1,35) = 31.35, p < 0.001, \eta^2 = 0.47 \), such that overall RTs were longest at an ISI of 2500 ms \( (Ms \text{ for } \text{ISI} = 2000, 2250, 2500, 2750, 3000 \text{ ms: } 716, 744, 759, 737, 720 \text{ ms, respectively}) \). The trial type × ISI interaction was also significant, \( F(4, 32) = 3.50, p = 0.018, \eta^2 = 0.30 \). Bonferroni corrected post hoc contrasts of BI versus control trials at each ISI revealed significant BI facilitation for trials at an ISI of 2000 ms, \( t(36) = -5.08, p < 0.001 \), replicating the RT results from Experiments 1 and 2. BI facilitation was also significant for trials at an ISI of 2250 ms, \( t(36) = -3.90, p < 0.001 \), but was non-significant for longer ISIs \( (ps > 0.01) \), in support of the time-limited model of BI mentioned earlier. Finally, we observed a significant main effect of age group, \( F(1,35) = 4.44, p = 0.042, \eta^2 = 0.113 \), due to shorter RTs in the young group \( (M = 714 \text{ ms}, \ SEM = 13.7) \) than in the older group \( (M = 756 \text{ ms}, \ SEM = 14.9) \). The remaining interactions were non-significant \( (ps \geq 0.14) \).
The BI effect was also examined using percent error scores and the same mixed factorial ANOVA design as above. This analysis revealed a significant main effect of trial type, $F(1, 35) = 5.22, p = 0.029, \eta^2 = 0.13$, due to slightly higher error rates during BI trials ($M = 8.1\%$, SEM = 0.76) compared to control trials ($M = 7.2\%$, SEM = 0.61). Consistent with the RT data, we did not find a significant interaction of trial type and age group ($p = 0.71$). The main effect of ISI proved significant, $F(4, 32) = 4.31, p = 0.007, \eta^2 = 0.35$. Polynomial contrasts indicate that the ISI function was cubic, $F(1, 35) = 171.59, p < 0.001, \eta^2 = 0.34$, due to fluctuating error rates (Ms for ISI = 2000, 2250, 2500, 2750, 3000 ms: 6.7, 8.7, 7.7, 7.0, 8.1%, respectively). The ISI factor also interacted significantly with age group, $F(4, 32) = 6.06, p = 0.001, \eta^2 = 0.43$. To follow up, we ran separate ANOVAs for each age group and found that whereas the ISI main effect was significant for young adults, $F(4, 16) = 11.75, p < 0.001, \eta^2 = 0.75$, it was not significant for the older adults ($p = 0.17$).

Related to the issue of the time course of BI facilitation, a significant trial type × ISI interaction was observed, $F(4, 32) = 5.75, p = 0.001, \eta^2 = 0.42$. Bonferroni corrected post hoc contrasts (alpha = 0.01) revealed that the interaction was due to a reversed BI effect that was only significant for ISIs of 2500 ms, $t(36) = -3.40, p = 0.002$. Finally, we observed a significant main effect of age group, $F(1, 35) = 4.96, p = 0.032, \eta^2 = 0.12$, due to fewer errors in young adults ($M = 6.2\%$, SEM = 0.90) compared to older adults ($M = 9.1\%$, SEM = 0.98).

As with the previous two experiments, we analyzed the latency data again with the addition of a switch factor to test if BI facilitation was restricted to trials following a sequential transition. The BI × Switch interaction was again very robust, $F(1, 35) = 31.22, p < 0.001, \eta^2 = 0.47$, owing to a reversal of the BI facilitation effect for trials not following a sequential transition (see Fig. 2).

Together, the BI analyses extend what was observed in the two previous SFT experiments. Consistent with Experiment 2, we did not observe age differences in the magnitude of BI effects. In this experiment, the RT analyses revealed BI facilitation only in the two shortest ISI conditions, consistent with a decay model of BI. Importantly, the interaction of ISI and BI did not interact with age group, indicating that older adults do not appear to have slower BI processes compared to young adults. The error analysis revealed a slight reversal of the overall BI benefit, suggesting the possibility of speed-accuracy tradeoffs. To address this possibility, we ran correlations between analogous RT and error measures for each condition (trial type × ISI). However, in every case, we found positive correlations between RT and errors (long RTs associated with more errors), disconfirming the presence of tradeoffs (see Table 4). Given this outcome, we offer the post hoc suggestion that participants may have become less attentive and consequently less accurate because the pace of the experiment was leisurely relative to the previous two experiments.

4.2.2. Flanker presence

To evaluate the effect of our ISI manipulation on the magnitude of flanker effects and possible age interactions, we carried out an age group (young, older) × trial type (flanked, unflanked) × ISI (2000, 2250, 2500, 2750, 3000 ms) mixed factorial ANOVA using correct median

### Table 3

<table>
<thead>
<tr>
<th>Trial type</th>
<th>ISI (ms)</th>
<th>BI</th>
<th>Neutral</th>
<th>Flanked</th>
<th>Unflanked</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median RT (ms)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger (n = 20)</td>
<td>2000</td>
<td>676 (16.6)</td>
<td>718 (13.6)</td>
<td>683 (14.5)</td>
<td>725 (15.1)</td>
</tr>
<tr>
<td></td>
<td>2250</td>
<td>707 (15.4)</td>
<td>745 (14.8)</td>
<td>694 (15.4)</td>
<td>706 (18.2)</td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>715 (21.5)</td>
<td>727 (14.9)</td>
<td>690 (13.5)</td>
<td>706 (19.6)</td>
</tr>
<tr>
<td></td>
<td>2750</td>
<td>711 (18.9)</td>
<td>719 (14.6)</td>
<td>689 (14.8)</td>
<td>660 (14.6)</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>694 (16.8)</td>
<td>725 (17.3)</td>
<td>709 (16.0)</td>
<td>710 (19.8)</td>
</tr>
<tr>
<td>Older (n = 17)</td>
<td>2000</td>
<td>712 (18.0)</td>
<td>757 (14.7)</td>
<td>723 (15.7)</td>
<td>731 (16.4)</td>
</tr>
<tr>
<td></td>
<td>2250</td>
<td>743 (16.7)</td>
<td>782 (16.0)</td>
<td>752 (16.7)</td>
<td>748 (19.8)</td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>792 (23.3)</td>
<td>799 (16.2)</td>
<td>742 (14.7)</td>
<td>752 (21.3)</td>
</tr>
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<td></td>
<td>2750</td>
<td>758 (20.5)</td>
<td>761 (15.8)</td>
<td>728 (16.0)</td>
<td>719 (15.8)</td>
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<tr>
<td></td>
<td>3000</td>
<td>724 (18.2)</td>
<td>755 (18.8)</td>
<td>723 (17.4)</td>
<td>726 (21.5)</td>
</tr>
</tbody>
</table>

| Error (%) | | | | | | |
| Younger (n = 20) | 2000 | 6.4 (1.2) | 4.2 (1.0) | 4.3 (0.7) | 2.0 (0.8) |
| | 2250 | 7.7 (1.3) | 6.4 (1.3) | 5.8 (0.8) | 3.6 (1.1) |
| | 2500 | 5.7 (1.4) | 4.2 (0.9) | 3.8 (0.6) | 2.4 (1.0) |
| | 2750 | 5.6 (1.2) | 5.7 (0.8) | 4.3 (0.6) | 2.9 (0.7) |
| | 3000 | 7.2 (1.1) | 8.5 (0.9) | 6.5 (0.5) | 2.9 (0.9) |
| Older (n = 17) | 2000 | 9.2 (1.3) | 7.1 (1.1) | 5.0 (0.8) | 3.7 (0.8) |
| | 2250 | 10.4 (1.4) | 10.2 (1.4) | 6.0 (0.9) | 3.4 (1.2) |
| | 2500 | 12.4 (1.5) | 8.5 (1.0) | 5.0 (0.6) | 4.7 (1.0) |
| | 2750 | 8.7 (1.3) | 7.8 (0.9) | 4.9 (0.7) | 2.4 (0.8) |
| | 3000 | 7.3 (1.2) | 9.5 (0.9) | 5.7 (0.6) | 2.6 (1.0) |
and interactions were non-significant ($p$ showed a performance advantage when there was a cate-
developed SFT paradigm, we found that both age groups
age group differences in BI efficiency. Using our newly
context of a sequential performance task, and to examine
5. General discussion
interpretation of BI results.
This revealed a significant main effect of ISI
was observed, $F(4, 32) = 6.12, p = 0.001, \eta^2 = 0.43$. Poly-
omial contrasts revealed a significant cubic component,
$F(1,35) = 15.16, p < 0.001, \eta^2 = 0.30$ ($Ms$ for ISI = 2000,
2250, 2500, 2750, 3000 ms: 716, 725, 722, 699, 717 ms,
respectively). The ISI main effect was qualified by an inter-
action with age group, $F(4, 32) = 3.72, p = 0.014,
\eta^2 = 0.32$. Follow-up ANOVAs revealed that for young
adults, the ISI function was characterized by significant
quadratic, cubic and fourth order components ($p < 0.05$)
due to slight fluctuations, whereas for older adults, the
ISI function was characterized by significant quadratic
and cubic components ($p < 0.05$). Cell means are shown in
Table 3. Trial type also interacted with the ISI factor,
$F(4, 32) = 5.43, p = 0.002, \eta^2 = 0.40$. Bonferroni corrected
contrasts (alpha = 0.01) revealed that the flanker presence
effect was only significant for trials with an ISI of
2750 ms, $t(36) = -2.85, p = 0.007$ ($M_{\text{flanked}} = 709$ ms,
SEM$_{\text{flanked}} = 10.7$; $M_{\text{unflanked}} = 690$, SEM$_{\text{unflanked}} = 10.7$).
All other main effects and interactions were non-significant
($ps \geq 0.17$).

A similar ANOVA was carried out using percent errors.
This revealed a significant main effect of trial type, $F(1,35) = 33.05, p \leq 0.001, \eta^2 = 0.49$, due to fewer errors
for unflanked ($M = 3.1\%, \text{SEM} = 0.31$) than flanked
($M = 5.1\%, \text{SEM} = 0.38$) trials. All other main effects
and interactions were non-significant ($ps \geq 0.12$).

Returning to the predictable stimulus location format
resulted in a marked attenuation of flanker presence effects,
as might be expected. The slight fluctuations of RT and
errors as a function of ISI mirror what was observed in
the BI analyses for Experiment 3, and are most likely due
to the smaller number of data points contributing to each
ISI condition. Nevertheless, the flanker analyses are consis-
tent with previous results in showing the absence of age
interactions with flanker presence, and thereby clarify the
interpretation of BI results.

5. General discussion
Our main goal was to examine the process of BI in the
context of a sequential performance task, and to examine
age group differences in BI efficiency. Using our newly
developed SFT paradigm, we found that both age groups
showed a performance advantage when there was a cate-
gorical relationship between targets on Trial $n-1$ and
flankers on Trial $n$, compared to successive trials in which
Trial $n$ flankers were from a less recently presented
category.

5.1. Backward inhibition and aging
The majority of our BI analyses revealed equivalent BI
facilitation effects in young and older adults, with the
exception of the marginal interaction noted in Experiment
1 for the RT data. Despite this exception, we did not observe significant age differences in BI effects elsewhere
in Experiment 1, nor when the selection demands of the
SFT were increased (Expt. 2), or when the ISI was
increased (Expt. 3). Thus, the majority of the present find-
ings suggest age-invariance in BI within the SFT paradigm,
in contrast to other situations involving inhibitory pro-
cesses which show age effects (e.g., Hartman & Hasher,
1991; Hasher, Quig, & May, 1997; Zacks, Radvansky, &
Hasher, 1996; but see Maylor & Henson, 2000).

The present results represent an important conceptual
replication of Mayr’s (2001) findings and extend those
results by combining an alternative operationalization of
BI (Hübner et al., 2003) with a sequential performance par-
adigm. Mayr’s investigation of task set switching revealed
statistically equivalent BI effects in older adults compared
to young, which was attributed to the obligatory nature
of BI (Mayr, 2001) within sequential performance situations
(i.e., one must move ahead to the next task/goal to
progress with the task). Given that the SFT is also sequen-
tial in nature, the present results support this interpreta-
tion (see also Kramer & Atchley, 2000).

5.2. General BI effects
Our results also replicate those of Hübner et al. (2003) in
showing BI facilitation, and extend them in several impor-
tant ways. First, the SFT differs from Hübner’s procedure
in terms of depth of processing: Our tasks were semantic in
nature (monitor for an exemplar from the insect category,
then an exemplar from the bird category, etc.) in compar-
ison to Hübner’s tasks, which involved more perceptual
decisions (e.g., consonant/vowel letters; straight/curved
symbols). Second, the two procedures differ in terms of
how task transitions are indicated: The SFT involved
endogenously driven task transitions, in that participants
were trained to switch to monitoring for the next category
in their learned sequence immediately following the detec-
tion of a target exemplar. In contrast, Hübner’s methodol-
ogy involved a mixture of precues and stimulus-driven
switches. Despite these methodological differences, we
obtained RT values (see Table 1) similar to the BI findings
reported by Hübner et al. (2003, Expt. 1: preceding vs. con-
tral flankers in the precued condition: ~ 635 and 655 ms,
respectively, from their Fig. 2).

The design of the SFT, which includes BI-type and con-
tral trials following both sequential transitions and no-
transition trials, allowed us to evaluate the rival hypothesis that BI facilitation was due to category priming from the target on Trial $n - 1$ to the flankers on Trial $n$. Across all three experiments, we found strong evidence against this rival hypothesis and support for the assumption that BI should only occur following the completion of one task set and transition to the next (Mayr & Keele, 2000). Fig. 2 also illustrates consistently slower overall response latencies following a transition compared to those following no-transition trials (main effect of switch for Expt. 1–3, $p = 0.06$, $<0.001$, $<0.001$, respectively), possibly owing to the need to retrieve the new category from long-term memory. The switch by age group interactions were non-significant in Experiments 1 and 3 ($p > 0.35$) but marginally significant in Experiment 2 ($p = 0.058$), possibly due to the heavier selective attention demands in that study.

5.3. Flanker presence

The basic flanker presence effect was not evident in Experiment 1, but was significant in the unpredictable location condition of Experiment 2 for both RT and error data, and to a lesser extent in the predictable location condition of Experiment 2 (error data only). In the third experiment, with a return to the predictable location condition and the introduction of slower ISIs, the magnitude of flanker effects diminished somewhat: in the RT data, flanker effects were only observed at an ISI of 2750 ms, whereas in the error data, a main effect of flanker presence was observed. The modest effects of flanker presence across all three studies, in comparison with other work, may be attributable to the low ratio of unflanked to flanked trials (13%:87%) which may have led to slower RTs for the less frequently occurring unflanked trials. Future research is needed to systematically evaluate the role of flanker ratio in the SFT.

With regard to age group contrasts, we found that young and older adults were comparably bothered by the presence of flankers, even when stimulus location was unpredictable. A survey of the previous research on aging and flanker effects reveals both the presence (e.g., Shaw, 1991; Zeef & Kok, 1993) and absence (Mitchell & Perlmutter, 1986; Wright & Elias, 1979) of age-related increases in flanker effects. One possible explanation for our null age findings was raised by Cerella (1985; see also Scialfa, Kline, and Lyman, 1987), who argued that the extent to which older adults are bothered by flankers depends on their useful field of view (UFOV). More specifically, age-related decline in UFOV (e.g., Sekuler, Bennett, & Mamalak, 2000) might give older adults an advantage in the flanker paradigm, given that they are less able to process stimuli presented in the periphery compared to younger adults. Nonetheless, several points lead us to discount the UFOV explanation in the present context. First, we designed our stimuli for all three experiments with the same visual angle specifications as Shaw (1991) to avoid this age-related confound. Second, we observed that older adults showed BI effects comparable to those of the young adults, which suggests that older adults were processing the flankers to a semantic level. Finally, if older adults could not process flankers because of diminished UFOV, we would expect the younger adults to be differentially more affected by the location manipulation in Experiment 2 compared to older adults. Instead, the two age groups showed comparable effects of stimulus location (i.e., no age group × location interactions in either flanker presence analysis). In sum, the flanker presence analyses were consistent in confirming that the young and older groups in each experiment did not differ in their vulnerability to flanker-type interference.

5.4. Conclusions

To summarize, we developed the SFT to study the specific inhibitory processes associated with making task transitions during sequential performance (BI). We extended the work on BI processes by using a sequential performance procedure, which is arguably more similar to everyday complex behaviors than task alternation procedures. Moreover, in contrast to other relatively molar methods of measuring sequential performance (e.g., Humphreys & Forde, 1998; Li et al., 2000; Logan, 2004), the SFT enables a more detailed analysis of underlying processes.

Our results replicate and extend the work reported by Hübner and colleagues (2003) and show that BI effects in the context of a sequential performance task may be obligatory and age-invariant (Maylor & Henson, 2000; Maylor et al., 2005; Mayr, 2001). Finally, the results provide clear evidence that BI processes reduce flanker interference from a previously relevant category only after participants have completed their search for that category. Further research is necessary to establish the generalizability of these results to other methodologies and tasks, and to examine whether patterns of neural activation in young and older adults parallel the reported behavioral results.

Acknowledgements

We thank Katherine Arbuthnott, Gesine Dreisbach, and one anonymous reviewer for helpful comments on previous drafts of the manuscript, and Ulrich Mayr for his input concerning the category priming hypothesis. We also thank the Natural Sciences and Engineering Research Council (NSERC) for grant support awarded to KZHL, and the Canadian Institutes of Health Research (CIHR) and NSERC for graduate fellowship support awarded to K.D. Experiment 1 was conducted as the Honors thesis project of K.D. We thank Madeleine Ward for her assistance with stimulus preparation and data collection for Experiment 2; Odelia Borten for assistance with manuscript preparation, programming and data collection for Experiments 2 and 3; and our research participants for their generous contribution of time and effort.
References


