The Error Protection Impact of Inhibitory After-effects in Location-based Tasks and Their Preservation with Practice

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Graduate Program in Kinesiology
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Arts
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THE ERROR PROTECTION IMPACT OF INHIBITORY AFTER-EFFECTS IN LOCATION-BASED TASKS AND THEIR PRESERVATION WITH PRACTICE

(Thesis format: Integrated Article)

by

Alexandra Lynn Stoddart

Graduate Program in Kinesiology

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts

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ABSTRACT

In location-based tasks, responses related to (prime trial) distractor-occupied locations automatically undergo activation, followed by inhibition, which causes these responses to become execution resistant. Distractor-response execution resistance takes time to override, causing detrimental inhibitory after-effects in the form of delayed target reactions that later require this response (e.g., the spatial negative priming phenomenon). We learned here that these puzzling detrimental inhibitory after-effects can also have a ‘beneficial’ influence, whereby the repelling impact of execution resistance reduced the likelihood of its response being used erroneously on the probe trial (i.e., execution resistance provides error protection). Ideally, execution resistance-induced error protection effectiveness, but not execution resistance override time (spatial negative priming), would remain unaltered with extensive practice executing prime-trial distractor response processing; however, both of these inhibitory after-effect characteristics exhibited a basic stability over time. Interestingly, while execution resistance override time is avoidable under some limited task conditions, this prevention seems difficult to achieve overall (including via practice), making the existence of this detrimental execution resistance consequence even more difficult to reconcile.

KEYWORDS: Spatial Negative Priming, Error Protection, Longevity, Inhibitory After-effects
CO-AUTHORSHIP

This thesis contains material that was submitted for publication. The principle author of this manuscript was Dr. Eric Buckolz, co-authored by Alexandra Stoddart and Cameron Edgar.
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INTRODUCTION

Contrary to instructions, and independent of whether their presentation is non-masked (visible) or masked (phenomenally invisible), visual distractors nonetheless frequently get processed, seemingly automatically and deeply, to the point of the retrieval of their associated responses (e.g., Bowman, Schlaghecken, & Eimer, 2006; Buckolz, Avramidis, & Fitzgeorge, 2008; Fitzgeorge, Buckolz, & Khan, 2011; Guy, Buckolz, & Khan, 2006; Schlaghecken, Rowley, Sembi, Simmons, & Whitcomb, 2007). When target location determines correct response selection (i.e., a location-based task), accumulating evidence, discussed in more detail later, indicates that distractor processing excludes the inhibition of the distractor-occupied location itself, while including the activation (A) and subsequent inhibition (I) of the distractor location’s related response (Buckolz, Fitzgeorge, & Knowles, 2012a; Buckolz, Edgar, Kajaste, Lok, & Khan, 2012b; Guy, Buckolz, & Khan, 2006; Lok, 2011). This distractor response inhibition is held to have two general consequences; one of which is immediate and well studied (e.g., Eriksen, Coles, Morris, & Gratton, 1985; Valle-Inclan & Redondo, 1988) and which causes, in whole or in part (see Houghton & Mari-Beffa, 2005), delays in the production of any concurrent competing target response. Presumably, these reaction time (RT) delays arise because the act of response inhibition is a time consuming process and, for whatever reason, while ongoing, delays the initiation of a required response.

The second consequence of an act of response inhibition is that it renders the involved response execution resistant (ER), which acts to prevent its execution and so must be overridden if the response is to be subsequently produced (Note - Tipper [2001] used the term ‘residual inhibition’ to denote a persistent impact of current distractor
inhibition; we prefer the ‘ER’ label simply because it focuses specifically on response inhibition, the sole cause of delays in location based tasks; Buckolz et al., 2012b; Guy et al., 2006). Because a representation of distractor processing is stored (Fitzgeorge & Buckolz, 2008), the distractor-response ER feature can be retrieved for the lifespan of this representation (at least 10 seconds for location-based tasks: Buckolz et al., 2008; Tipper, Weaver, Cameron, Brehaut & Bastedo, 1991) and so ER can exert an influence on later processing (henceforth, ‘inhibitory after-effects’). In short, distractor response processing is held to include its activation, inhibition and its becoming execution resistant (i.e., A→I→ER) [Buckolz et al.; Fitzgeorge et al., 2011].

Three ER-induced inhibitory after-effects (IAEs) have been identified in location-based tasks (i.e., A→I→ER→IAEs), where target and/or distractor events are delivered in related (sequential) trial pairs; first the ‘prime’, and then the ‘probe’ (Schematic 1).

Subjects respond to a target’s spatial position while attempting to ignore any distractor event that might be present. The most studied of these inhibitory after-effects is the latency indexed spatial negative priming (SNP) phenomenon. Here, reaction time for the probe target is significantly longer when it arises at the position formerly occupied by the prime trial distractor event (i.e., an ignored-repetition [IR] trial), relative to when it appears at a previously unoccupied location (i.e., control trial) [e.g. Neill, Terry, & Valdes, 1994]. The comparatively greater IR reactions arise because of the time needed to ‘override’ the ER feature of the prime distractor response on ignored-repetition, but not on control trials. The RT(IR) > RT(control) latency inequality typically defines the SNP phenomenon (Schematic 2).
Schematic 1: An illustration of the distractor response processing (DRP) sequence. The distractor location’s related response is activated (A), then subsequently inhibited (I), which creates execution resistance (ER) to that response being used. ER induces inhibitory after-effects (IAE) which exert an influence on further processing.
Schematic 2: An illustration of the basic spatial negative priming (SNP) effect. SNP is deemed to be present when reaction times to the Ignored-Repetition Trials (IR: Probe Trial Target \([T]\) at Prime Trial Distractor \([D]\) location are longer than reaction times to the Control Trials (CO Probe T at a previously unused location). The study conducted in this experiment used target or distractor only prime trials.
A second ER-induced inhibitory after-effect manifests itself when manual response error rates are higher for ignored-repetition than for control trials (e.g., Buckolz et al., 2008; Fitzgeorge & Buckolz, 2008). Presumably, this error imbalance is caused because, on rare occasions, efforts to override the ER feature of the distractor response on ignored-repetition trials are unsuccessful, so that a response selection error necessarily occurs (i.e., a button-press error). This conflict between ER and the probe target for response control is absent on control trials, keeping its error rate comparatively smaller.

Finally, the third inhibitory after-effect shows up on free choice trials, where two permissible responses have been assigned to a single location. Subjects showed a significant selection-bias against choosing a former (prime trial) distractor response when it competed against a control response (Fitzgeorge et al., 2011; Lok, 2011). The aversion to choosing the distractor response presumably reflected its ER feature. Notably, on free choice trials, unlike the case for the usual forced choice trials, prime-trial distractor-response ER is not opposed by the mandatory dictates of the probe target, and so more readily manifest its existence (i.e., the selection bias against the distractor response is greater [free choice trials] than the ignored-repetition and control response error rate difference [forced choice trials]).

Following their discovery (e.g., NP; Dalrymple-Alford & Budayr, 1966), inhibitory after-effects subsequently garnered considerable theoretical and experimental attention because they revealed, contrary to the prevailing view (e.g., Broadbent, 1958), that distractor processing did not immediately fade away unnoticed following some preliminary processing. Rather, it persisted over time, with capabilities of influencing later related processing (e.g., Fox, 1995; May, Kane, & Hasher, 1995; Neill, 2007;
Tipper, 2001). While the presence of inhibitory after-effects in location-based (and other) tasks has been informative in this regard, they are, nonetheless, puzzling in that they represent dysfunctional processing (i.e., the first two inhibitory after-effects listed above); they show an interference with task-appropriate target processing (on ignored-repetition trials). One wonders why helpful acts of response inhibition, used to successfully resolve prime-trial response conflicts (e.g., Houghton & Mari-Beffa, 2005), should be encumbered with consequent detrimental inhibitory after-effects? In a remedial/reconciliation vein, two questions arise; one is whether these deleterious after-effects are an inevitable cost of previous response inhibition acts, or whether they can be set aside? The second question asks whether inhibitory after-effects have as yet untested beneficial outcomes. One major interest in this report was to address these queries; the former by highlighting past associated work, the latter through experimentation.

Regarding the first question dealing with avoidance, the processing giving rise to inhibitory after-effects in location-based tasks does include a prevention mechanism; however, its intervention is limited to only those instances when specific task pre-requisites are present (i.e., predictable IR trials, the predictable/certain probe distractor absence: Buckolz, Boulougouris, & Khan, 2002; Buckolz et al., 2012b; Fitzgeorge & Buckolz, 2008; Guy, Buckolz, & Pratt, 2004). When these prevention pre-requisites are absent, as is the case with the usual SNP task (e.g., Fitzgeorge & Buckolz, 2008; Neill, 2007; Tipper, 2001), we are seemingly helpless in avoiding negative inhibitory after-effects via the intervention mechanism.
With respect to the second question, a logical positive inhibitory after-effect was suggested by Fitzgeorge et al. (2011), a version of which is outlined next. Testing the predictions of this version is one of the major specific objectives of the current work.

‘Protection’ Against Response Selection Errors on the Probe Trial in Location-based Tasks: a Positive Influence of a Distractor-response’s Execution Resistance (ER) Feature

Simply put, the idea is that the ER feature of a just-inhibited prime distractor response should ‘protect’ against its erroneous selection at a later point in time (probe trial), repelling its (non-required) selection in much the same way as ER opposed distractor-response selection on free choice trials (Fitzgeorge et al., 2011, Lok, 2011). Evidence of such a ‘beneficial’ inhibitory after-effect would see ER-protected prime distractor responses used incorrectly less often on probe trials than would be the case for their non-protected (control) counterparts. We were able to test this possibility for both target-only and target-plus-distractor probe trials. In addition to possibly providing corroborative results for the target-only probe trials, the target-plus-distractor probe trials were important because they allowed us to test the ER error protection idea more broadly than did the target-only probes (see Schematic 3). We illustrate this point next.

With the target-plus-distractor probes, we assume that a distractor-occupied location will activate and so provoke the execution of its assigned response (Fitzgeorge et al., 2011). Accordingly, four prime-probe trial Categories are formed by crossing the ER ‘protection’ (yes/no) and the activation ‘provocation’ (yes/no) factors (Schematic 3). Specifically, both ‘ER protection’ and ‘provocation’ can be absent, ‘ER protection’ but not ‘provocation’ can be present, ‘provocation’ can occur without ‘ER protection’, and,
Schematic 3: An illustration of the four prime-probe trial categories formed by whether or not a pair includes execution resistance (ER) error protection, and/or a provocation of its response by a probe-trial distractor on target-plus-distractor probe trials. Target-only probe trials involve only categories [1] and [2]. A ‘check mark’ indicates presence, an ‘x’ absence.
finally, both ‘protection’ and ‘provocation’ can be present (Categories [1], [2], [3], and [4]), respectively, Schematic 3). Naturally, for the target-only probe-trial type, only Conditions [1] and [2] arise.

With regard to predictions, greater probe-trial error rates should occur for Category [1] than for Category [2] for both probe-trial types, indicative of the fact that the distractor-response ER feature helps to protect against its erroneous use when it is not subsequently activated. Further, larger error frequencies for Category [3] than for Category [4] are expected and would signal that ER protection against faulty selection extends to former distractor responses that are urged into action by an external event (i.e., probe distractor). The degree to which this error protection is effective will be indicated by how the error rates for Categories [4] and [2] compare. Comparable error rates would indicate that ER protection is equally effective whether its associated response is later externally provoked [4] or not [2], at the time of target delivery.

If an ER-induced Protection against Faulty Response Selection Exists, Does It Persist With Extensive Practice with the Same Task?

For ER-induced protection against response selection errors to be a meaningful counter to the detrimental inhibitory after-effects that follow distractor response inhibition, it ought to persist over time (i.e. not dissipate with practice). Other than this logic, conjecture on this matter is difficult. For one thing, to our knowledge, there are no published accounts and no explicit predictions set forth by any of the main NP theories (e.g., Buckolz et al., 2012; Houghton & Tipper, 1994; Neill, 2007; Tipper, 2001), which have dealt with the longevity of any of the inhibitory after-effects produced in location-
based tasks. This includes the SNP phenomenon itself. The other difficulty is that predictions require multiple untested assumptions. For example, if distractor potency (i.e., RT[target-plus-distractor] minus RT[target-only] = response inhibition time) declines with practice, and if this then reduces ER magnitude, which can then be overridden more quickly, SNP size would decrease with practice. A further question is whether a reduced ER magnitude is less protective against response selection errors, or whether the two, more ideally, respond independently to practice, if they respond at all. The uncertainty of all of these possible relationships makes a practice effect prediction unjustifiable. In any event, the aim here is simply to determine whether inhibitory after-effects (both negative and beneficial) in location-based tasks persist over extensive practice. The impact of practice effects on the presumed distractor-response processing sequence (A→I→ER) that causes the inhibitory after-effects (Buckolz et al., 2012) represents a minor interest in this study, and will be tested by looking to see if practice effects on distractor interference and SNP size are related.

METHOD

Participants

Thirty undergraduate students (15 male, 15 female), ranging in age from 20-25 years and with normal or corrected-to-normal vision, participated in this experiment. Participants were tested individually and received course credit.

Apparatus

The visual input display was presented in a dimly lit room on a 47.5 cm computer screen situated on a tabletop 73.5 cm above the floor. The display consisted of a fixation cross that appeared in the center of the screen, accompanied on each side by two
horizontal bar markers that served as locations for target (T) and/or distractor (D) presentation. For ease of reference, these are denoted as L1-L4, going left to right. The fixation cross measured 0.9 cm in width and was white in colour. The fixation cross and the bar markers were white and appeared against a black background. Bar markers L2 and L3 were each separated from the fixation cross by a distance of 2.4 cm, thus separated from each other by a distance of 4.8 cm. Bar markers L1 and L4 were each separated from the fixation cross by a distance of 3.8 cm, and were thus separated from each other by a distance of 7.6 cm. With participants seated 196 cm from the display, this created a horizontal visual angle of about 2.2° for the bar markers. The to-be-responded-to target and the to-be-ignored distractor rectangles were the same size (0.9 cm wide and 1.9 cm high), but differed in colour with the target being green and the distractor being red.

A four response protocol was used. The keyboard responses of ‘D,’ ‘V,’ ‘L’, and ‘M’ were mapped onto their spatially compatible bar marker locations (L1, L2, L3, and L4) and were controlled by the left middle and index fingers of the left hand and by the index finger and third digit of the right hand, respectively.

Procedure

Trials were presented in pairs, first the prime and then the probe. A single target or a distractor appeared with equal frequency on the prime trial, while the probe trial contained either a target alone or a target plus a distractor.

All trials began with a 100 ms warning tone whose offset was immediately followed by the display configuration (bar markers and fixation cross), which remained
on the screen for an entire prime-probe trial sequence (refer to Schematic 4 throughout). Two hundred milliseconds after the onset of the configuration, the prime-trial event, distractor or target, appeared for 157 ms. It was followed 700 ms later by the probe trial which contained a target plus a distractor or a target stimulus alone, and which again lasted for 157 ms. The execution of the correct probe-trial response initiated an inter-trial duration of 1500 ms that culminated in the presentation of the warning tone and the beginning of the next trial sequence. An incorrect probe-trial response did not initiate the inter-trial duration until the participant responded correctly.

The study included seven lab visits with each lab visit consisting of two Sessions (with a break of five minutes in between). Participants completed 14 Sessions consisting of 224 prime-probe trial pairs. Each Session contained an equal number of target and distractor prime trials, which appeared randomly and equally often at all possible locations. The trial breakdown for a Session is indicated in Table 1 (i.e., Session # 1), which also includes the cumulative number of trials experienced as the Sessions continued.

Participants were informed that trials would be completed in pairs (a prime trial and a probe trial). A beep (warning signal) initiated each onset of a prime in a new pair. Participants were directed to respond to the corresponding target (green rectangle) by depressing the appropriate key. They were also informed to ignore distractor-occupied locations (red rectangles) that may appear. Additionally, they were directed to respond as quickly as possible while minimizing button-press errors. Participants were instructed to avoid anticipation (responding before a stimulus had appeared; responding faster than 100 ms). Previous to starting the experimental session, participants completed five
Schematic 4: An illustration of the timing of events for a typical prime-probe trial sequence involving either a distractor-only [3A] or a target-only [3B] prime trial, followed either by a target-plus-distractor [5A] or a target-only [5B] probe trial. □ = to-be-responded to target event, ■ = to-be-ignored distractor event. IR= Ignored-repetition trial, TR= Target repetition trial.
Table 1

The number and types of trials experienced within a Session (# 1) for distractor (cols. 4-6 & 9-10) or target (cols. 1-3 & 7-8) primes. The cumulative numbers of these trial types over each successive Session is also recorded (Sessions # 2-14). Probe trial designations: T+D= target-plus-distractor, T-only= target only, TR= target-repeat, CO=control, d@T= probe distractor at prime target location, d@d= distractor at the same prime and probe location.

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<td>672</td>
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</tbody>
</table>
practice trial pairs and had any questions answered to ensure comprehension of task requirements.

**Design**

The experimental design was a 3-way factorial (14 x 2 x 2), with Sessions (1-14), Probe Type (target-plus-distractor, target-only), and Trial Type (ignored repetition or target repetition vs. control) serving as within-subject factors.

**RESULTS**

Trials where button-press errors occurred on the prime and/or probe trials, along with instances where response times were less than 100 ms (i.e., anticipations) or exceeded 900 ms (insufficient vigilance), were excluded from all latency analyses.

**Probe-trial Data**

**Following Distractor-only Prime Trials**

Spatial Negative Priming (SNP) – Execution Resistance (ER) Override Time – and Practice. An Analysis of Variance (ANOVA) was calculated using mean reaction times with Sessions (14), Trial Type (ignored-repetition [IR], control [CO]), and Probe Type (target-only, target-plus-distractor) serving as the main factors. The cell means for this analysis are plotted in Figure 1 (also see Tables 2 & 3).

These models (Sessions, F(13, 377) = 48.49, p < 0.01, MSE= 667; Probe Type, F(1, 29)= 209.65, p < 0.01, MSE= 622; and Trial Type, F(1,29)= 193.67, p < 0.01, MSE= 192) all produced significant main effects: expectedly, reactions were significantly slower when the probe trial contained a distractor (451 ms vs. 434 ms) and when ignored-repetition trials occurred (SNP effect; 458 ms vs. 428 ms). More important, though, Trial Type
Figure 1: Mean Probe-trial reaction times as a Function of Probe-trial Type (ignored repetition vs. control), Probe-trial Content (target-only; target-plus-distractor) and Sessions (1-14). Each Session consisted of 224 prime-probe trial pairs.
Table 2

Mean probe-trial reaction times (ms) as a function of Probe-trial Type (ignored-repetition [IR] vs. control [CO] trials) as a function of Sessions (1-14; each Session consisted of 224 prime-probe trial pairs) for the target-plus-distractor probe trials.

<table>
<thead>
<tr>
<th>Session</th>
<th>1</th>
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<th>3</th>
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<tbody>
<tr>
<td><strong>Trial-type (T+D)</strong></td>
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<td></td>
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<tr>
<td>Ignored-repetition</td>
<td>522 (10.6)</td>
<td>490 (8.8)</td>
<td>480 (7.4)</td>
<td>464 (6.4)</td>
<td>469 (6.9)</td>
<td>462 (7.1)</td>
<td>464 (7.6)</td>
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<tr>
<td></td>
<td>[0.12]</td>
<td>[0.11]</td>
<td>[0.08]</td>
<td>[0.08]</td>
<td>[0.06]</td>
<td>[0.08]</td>
<td>[0.06]</td>
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<tr>
<td>Control</td>
<td>452 (5.5)</td>
<td>460 (6.5)</td>
<td>456 (6.5)</td>
<td>454 (5.7)</td>
<td>453 (5.9)</td>
<td>448 (5.8)</td>
<td>448 (6.1)</td>
</tr>
<tr>
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<td>[0.07]</td>
<td>[0.08]</td>
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<tr>
<td><strong>Spatial Negative Priming</strong></td>
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<td>*40</td>
<td>*31</td>
<td>*23</td>
<td>*28</td>
<td>*23</td>
<td>*27</td>
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</table>

*Note. Spatial Negative Priming = Ignored-repetition – Control; ( ) = standard error (ms); [ ] = button-press error percent. *p<0.01.
Table 3

Mean probe-trial reaction times (ms) for Probe-trial Type (ignored-repetition [IR] vs. control [CO] trials) as a function of Sessions (1-14; 224 prime-probe pairs per Session) for target-only probe trials.

<table>
<thead>
<tr>
<th>Session</th>
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<tbody>
<tr>
<td><strong>Trial-type (T-only)</strong></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Ignored-repetition</td>
<td>502 (7.9)</td>
<td>472 (8.4)</td>
<td>458 (5.8)</td>
<td>455 (5.7)</td>
<td>453 (5.8)</td>
<td>451 (6.6)</td>
<td>446 (5.8)</td>
</tr>
<tr>
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<td>[0.09]</td>
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<td>[0.06]</td>
<td>[0.04]</td>
<td>[0.07]</td>
</tr>
<tr>
<td>Control</td>
<td>445 (6.6)</td>
<td>443 (6.1)</td>
<td>438 (5.9)</td>
<td>440 (5.8)</td>
<td>438 (5.7)</td>
<td>431 (4.6)</td>
<td>429 (4.4)</td>
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<td>[0.05]</td>
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</tbody>
</table>

Note. Spatial Negative Priming = Ignored-repetition – Control; ( ) = standard error (ms); [ ] = button-press error percent. *p<0.01.
interacted significantly with Sessions, $F(13, 377) = 4.71, p < 0.01, \text{MSE}= 230$. Visual inspection of Figure 1 indicated that SNP size likely changed within the first three Sessions. Accordingly, we contrasted the SNP values for Sessions 1, 2, and 3 separately for each Probe Type using correlated t-tests. Only the SNP differences between Sessions 1 and 3 produced significant t-values ($t[58]= 2.36, p= .022; t[58]= 1.82, p= .07$: for target-only and target-plus-distractor probe types, respectively). Further, with the first Session discarded, the ANOVA calculations again produced significant Sessions, $F(12, 348)= 23.54, p<0.01, \text{MSE}= 523$, and Trial Type, $F(1, 29)= 180.69, p< 0.01, \text{MSE}= 1763$, main effects; their interaction was significant, $F(12, 348)= 2.126, p<0.05, \text{MSE}= 231$, however the three-way interaction with Probe Type was not significant, $F(12, 348) = 1.16, p=0.306, \text{MSE}=185$.

*Distractor Potency/Interference and Practice.* Distractor potency was calculated for each Session, indexed as the reaction time difference between probe targets accompanied by a distractor (i.e., target-plus-distractor) versus those which appeared alone (i.e., target-only) [Table 4]. These values were then submitted to a one-way ANOVA with Sessions (1-14) as the main factor. The Sessions main effect was significant, $F(13, 377) = 3.11, p< 0.01, \text{MSE}= 179$; however, the Newman-Keuls test ($p< 0.05$) revealed that only 5 of the possible 91 pair-wise comparisons were significant, basically involving contrasts between Sessions 1 and 3 (interference= 26 ms) with Sessions 12 and 13 (12 ms).
Table 4

Interference (probe-trial reaction times (ms) [target-plus-distractor] minus reaction times [target-only]) over Sessions (1-14; each Session consisted of 224 prime-probe trial pairs).

<table>
<thead>
<tr>
<th>Session</th>
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<tbody>
<tr>
<td></td>
<td>26 (2.7)</td>
<td>18 (2.9)</td>
<td>25 (2.2)</td>
<td>20 (3.1)</td>
<td>20 (2.2)</td>
<td>22 (2.2)</td>
<td>22 (2.5)</td>
</tr>
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</table>

<table>
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<tr>
<th>Session</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18 (2.6)</td>
<td>23 (2.2)</td>
<td>15 (2.6)</td>
<td>21 (3.0)</td>
<td>12 (2.2)</td>
<td>13 (2.2)</td>
<td>17 (2.8)</td>
</tr>
</tbody>
</table>

Note. ( ) = standard error (ms); Sessions 1 and 3 differed significantly from Sessions 12 and 13, (p < 0.05).
**Execution Resistance (ER), Selection Error Protection, and Practice.**

Button-press errors were classified for target-plus-distractor probe trials according to whether the involved response had just served as a prime distractor or as a prime control response (i.e., ER protection vs. no ER protection, respectively), and upon whether the response was currently associated with a probe distractor-occupied location or an empty probe-trial location (i.e., whether it had been ‘provoked’ into action [activated] vs. not, respectively). This produced four prime-probe trial Categories (Schematic 3), only two of which arose with target-only probe trials (i.e., [1] & [2], Schematic 3) because they lacked the provocation basis of classification noted above. The percent of the actual committed probe-trial selection errors attributable to each Category for each Session are plotted in Figures 2 and 3 for target-plus-distractor and target-only probe trials, respectively, excluding ignored-repetition trials (also see Table A1).

Exclusive of the ignored-repetition trials, button-press errors occurred on 4.0% of the target-plus-distractor probe trials. An analysis of variance (ANOVA) was conducted using probe-trial button-press error percentages for each subject, and with Category ([1], [2], [3], & [4]; Schematic 3) and Sessions (1-14) serving as the main factors. Category produced the only significant effect, $F(3, 87) = 72.72, p < 0.01, \text{MSE} = 1483$, (remaining $F$-values were < 1). Post hoc Newman-Keuls tests ($p < 0.05$) applied to the Category main effect revealed that all pair-wise comparisons were significant. Error rates were most common for Category [1] 35.6%, progressively declining thereafter for Categories [2] through [4]; 25.6%, 7.27% and 1.03%, respectively (Fig. 2). Notably, button-press
Figure 2: Of the probe-trial response errors committed per Session (excluding ignored-repetition trial errors), what percent of these is caused by each of the four Categories illustrated in Schematic 3: i.e., both prime and probe locations are empty (no ER protection – no response provocation), prime contains distractor but probe location is unoccupied (ER protection – no provocation), prime location is empty but probe location is occupied by a distractor (no ER protection – provocation), and, both prime and probe locations contain a distractor (ER protection – provocation). These are numbers [1], [2], [3], & [4], respectively, in Schematic 3. Each Session consisted of 224 trial-probe pairs. For distractor-plus-target probe trials.
Figure 3: Of the probe-trial response errors committed per Session (excluding ignored-repetition trial errors), what percent of these is caused by two of the four Categories illustrated in Schematic 3: i.e., both prime and probe locations are empty (no ER protection – no response provocation), prime contains distractor but probe location is unoccupied (ER protection – no provocation). These are numbers [1], & [2], respectively, in Schematic 3. Each Session consisted of 224 prime-probe trial pairs. For target-only probe trials.
responses associated with ER protection were used erroneously (Categories [2] & [4])
less often than those responses lacking this protection.

With the target-only probe trials, button-press errors arose on 3.8% of the control
trials undertaken. For the target-only probes, Category ([1]) was represented twice as
often as the ER-protected response Category ([2]). Accordingly, we tested the ER error
protection idea using a Chi Square analysis, taking the trial type probability imbalance
into account when establishing expected frequencies. Consistent with the assumptions of
a Chi Square analysis, none of the expected values were less than one, and no more than
20% of the expected values were less than five. For this Chi Square analysis, all of the
expected values were over five. Chi Square values ranged from 0.53 to 4.08 over
Sessions (9 were less than 1.0), and only in the latter instance was the critical Chi Square
value for 1 degree of freedom exceeded (i.e., 3.84, \( p < 0.05 \)).

*Error Rates for Ignored-repetition Trials.* An ANOVA was calculated
using button-press error rates with Trial Type (ignored-repetition [IR] & Control),
Sessions (1-14) and Probe Type as the main factors. Unlike Sessions, \( F(13, 377) = 1.56, \)
\( p = 0.10, \text{MSE} = 770 \), Probe Type and Trial Type produced significant main effects, as
did their interaction, \( F(1, 29) = 84.57, \ p < 0.01, \text{MSE} = 2606 \). A Newman-Keuls test (\( p <
0.05 \)) applied to this interaction revealed that error rates were significantly more frequent
for IR than for Control trials for the target-plus-distractor probe trials, with the reverse
being the case when the probe contained only a target.

*Following Target-only Primes*

*Target-repeats and Practice.* An ANOVA was calculated using mean
reaction times for each subject with Sessions (1-14), Probe Type (target-plus-distractor,
Figure 4: Mean Probe-trial reaction times as a Function of Probe-trial Type: target repeat (event identity, location and response are repeated on sequential trials) vs. control (only event identity is repeated), Probe-trial Content (target-only; target-plus-distractor) and as a function of Sessions (1-14). Each Session consisted of 224 prime-probe trial pairs.
Table 5

Mean probe-trial reaction times (ms) as a function of Probe-trial Type (target-repetition [TR] vs. control [CO] trials) as a function of Sessions (1-14; each Session consisted of 224 prime-probe trial pairs) for the target-plus-distractor probe trials.

<table>
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<th>Session</th>
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<td><strong>Trial-type (T+D) Target-repetition</strong></td>
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<tr>
<td></td>
<td>477 (6.7)</td>
<td>449 (4.1)</td>
<td>444 (5.6)</td>
<td>432 (5.1)</td>
<td>435 (4.8)</td>
<td>429 (5.6)</td>
<td>427 (5.5)</td>
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<td>[0.07]</td>
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<td>426 (4.8)</td>
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<td>421 (5.3)</td>
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<td>419 (4.1)</td>
<td>424 (4.2)</td>
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<td>[0.05]</td>
<td>[0.04]</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>499 (10.1)</td>
<td>467 (7.6)</td>
<td>461 (7.2)</td>
<td>449 (6.4)</td>
<td>446 (5.9)</td>
<td>448 (6.7)</td>
<td>442 (5.8)</td>
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<td>[0.06]</td>
<td>[0.08]</td>
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<td>439 (6.0)</td>
<td>443 (6.5)</td>
<td>433 (6.4)</td>
<td>438 (5.6)</td>
<td>433 (5.5)</td>
<td>431 (4.7)</td>
<td>434 (5.5)</td>
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<td>[0.06]</td>
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<td>[0.05]</td>
<td>[0.04]</td>
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</table>

**Target-repetition Effect**

*Note.* Target-repetition Effect = Target-repetition – Control; ( ) = standard error (ms); [ ] = button-press error percent. *p<0.01, **p<0.05.
Table 6

Mean probe-trial reaction times (ms) for Probe-trial Type (target-repetition [TR] vs. control [CO] trials) as a function of Sessions (1-14; 224 prime-probe pairs per Session) for target-only probe trials.

<table>
<thead>
<tr>
<th>Session</th>
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<td>401 (4.3)</td>
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<td>398 (4.3)</td>
<td>397 (4.9)</td>
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<td>399 (4.9)</td>
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<td><strong>Control</strong></td>
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<td>469 (8.9)</td>
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<td>438 (7.3)</td>
<td>434 (7.1)</td>
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<td>[0.09]</td>
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</tr>
<tr>
<td></td>
<td>425 (6.1)</td>
<td>425 (6.8)</td>
<td>425 (6.5)</td>
<td>422 (5.2)</td>
<td>419 (5.2)</td>
<td>415 (4.6)</td>
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</tr>
</tbody>
</table>

**Target-repetition Effect** = Target-repetition - Control; ( ) = standard error (ms); [ ] = button-press error percent. *p<0.01.

Note. Target-repetition Effect = Target-repetition - Control; ( ) = standard error (ms); [ ] = button-press error percent. *p<0.01.
target-only) and Trial Type (target-repeat [the same target appeared in the same location on a prime-probe trial pair], control [only the prime target was reused on the probe trial]).

The cell means for this analysis are presented in Figure 4 (also see Tables 5 & 6). All three main factors produced significant main effects: Sessions, $F(13, 377) = 49.96$, $p<0.01$, MSE=490; Probe Type, $F(1, 29) = 372.14$, $p<0.01$, MSE=574; and Trial Type, $F(1, 29) = 32.37$, $p<0.01$, MSE=4949, as did all two-way interactions (Sessions x Probe Type, $F[13, 377] = 4.61$, $p<0.01$, MSE=168; Sessions x Trial Type, $F[13, 377] = 1.81$, $p<0.05$, MSE=250; Probe Type x Trial Type, $F[1, 29] = 61.38$, $p<0.01$, MSE=181). The three-way interaction was non-significant, $F<1$. This same ANOVA result pattern was replicated when the first Session was not included, with the exception that the Sessions x Trial Type interaction was no longer significant, $F(12,348) = 1.518$, $p=0.115$, MSE=230.

Overall, the Trial Type main effect revealed that the latencies for target-repeat trials (419 ms) were significantly faster than for control (430 ms) trials. The Newman-Keuls test applied to the Trial Type x Sessions interaction revealed that this reaction time inequality was significant for all Sessions.

**DISCUSSION**

*Execution Resistance Override Time (SNP effect) and Practice*

The time needed to override the execution resistance (ER) feature of a former distractor-related response in a location-based, held to exclusively cause the SNP phenomenon (Buckolz et al., 2012; Fitzgeorge et al., 2011; Guy et al., 2006), does undergo a significant reduction in size early (i.e., Session 1 vs. Session 3 and onward), but, thereafter, its significant presence remains uninfluenced with further extensive practice (i.e., the last 13 Sessions) [Fig. 1].
Even though distractor response processing is held to occur automatically (Fitzgeorge et al., 2011), we entertained the possibility that the likely immutable automatic operations involved with this response processing (activation→inhibition→execution resistance: A→I→ER) are modifiable, in this case by practice. This possibility was suggested by prior work showing that automatic processing in an identity-based task exhibited flexibility. For example, O’Connor and Neill (2010; also see Boy & Sumner, 2010) showed that masked distractor events retrieved newly assigned responses when subjects transferred from an S-R compatible to an S-R (new response) incompatible task. The decrease in override time here (i.e., SNP size) also showed flexibility related to automatic processing, albeit in a less dramatic way. ER degree might have declined over practice, either because distractor response inhibition becomes easier/faster (i.e., reduced distractor potency), and/or because of direct practice with ER override trials, or both.

It is not possible here to definitively distinguish among the foregoing options. We do note, however, that distractor interference did not show an orderly, significant size reduction as Sessions continued (Table 4). There are two implications here. One is that it shows that distractor response inhibition time (i.e., distractor potency) remains remarkably consistent over practice. This assumes that the target vs. distractor discrimination requirement played little or no role in distractor interference, partly because the discrimination between colours is an easy one (see Reisberg, Baron, & Kemler, 1980 who make a similar point with the Stroop task), especially with extended practice. The other implication is that the relationship between interference and SNP size cannot be assessed, since both measures were basically stable over practice.
Independence was suggested, however, since when one varied significantly over Sessions, the other did not.

From another perspective, the continued presence of significant distractor interference over Sessions indicates that we should not expect this interference to dissolve entirely over practice whenever distractor processing includes manual response inhibition. This point might help reconcile the current interference stability findings with those who report that inhibition/distractor effects can decline (Reisberg et al., 1980) or be removed (Dixon, Ruppel, Pratt, & De Rosa, 2009) with practice.

Finally, the persistence of an SNP effect (i.e., ER override time) over extended practice, after an initial decline, is worthy of notice. This is not only because it is consistent with the view that distractor response inhibition time remains invariant over Sessions, but also because it has an unfortunate aspect. It means that the detrimental inhibitory after-effect imposed upon later target processing (ignored-repetition trial) resulting from earlier distractor response processing, is not set aside with practice. Apparently, escaping ER override time delays associated with the later use of former distractor responses must be achieved by other means; such as through appropriate task conditions (e.g., distractor-free probe trials, and/or predictable ignored-repetition trials: Fitzgeorge et al., 2008; Guy et al., 2004). This prevention is presumably achieved by blocking the retrieval of stored (prime) distractor processing representations (Buckolz et al., 2012; Fitzgeorge et al.) during probe-trial processing.

Nonetheless, broadly speaking, maladaptive, detrimental inhibitory after-effects resulting from distractor response inhibition are difficult to avoid in environments where the relevancy status of locations/events can randomly fluctuate (e.g., ignored-repetition
trials). Accordingly, the main question here was whether such processing negativity is somewhat offset by a compensating beneficial impact of these inhibitory after-effects.

A Beneficial Influence of Inhibitory After-effects in Location-based Tasks: Protection against Response Selection Errors.

For the first time we believe, we saw here that inhibitory after-effects in location-based tasks can make a positive processing contribution in the form of (probe trial) error protection. Former distractor, ER-protected responses are erroneously used significantly less often than are their respective control response counterparts. This holds whether the ER-protected response is subsequently activated by a probe-trial distractor (i.e., distractor-repeat on target-plus-distractor probe trials) or not (i.e., Fig. 2; [1] vs. [2] and [3] vs. [4], Schematic 3). Notably, however, this distractor-response error protection is not evident when the probe trial randomly contains only a target. In retrospect, this finding can be explained by results and speculation reported by Fitzgeorge and Buckolz (2008) and by Buckolz et al. (2012) in a way that reconciles it with the data for the target-plus-distractor probe trials.

These authors proposed that a representation of prime distractor processing is stored and is independently retrieved either when the probe-trial target appears at the former distractor-occupied location (i.e., ignored-repetition trial), and/or by the presence of a probe-trial distractor. Neither of these retrieval pre-requisites is met by control trials on target-only probe trials. Consequently, the ER property of the former distractor response would not be retrieved and so could not afford error protection for this response during probe-trial processing, as we found here for target-only probe trials. If this
proposal is correct, it bears pointing out explicitly that we need to explain the RT(ignored-repetition) > RT(control) difference (i.e., SNP effect) in a slightly different way than in the past. Specifically, the reason for faster control trial latencies is not only that they do not involve any of the prime-trial distractor processing components (previous thinking), but, even if they did, it would not matter since these components would not be associated with the inhibitory after-effects related to prime-trial processing.

So, support for ER-generated error protection is not opposed by our target-only probe trial data. Importantly, this protection, when functional, retains its effectiveness throughout extensive practice with the same task. This matches the durability of the detrimental inhibitory after-effects considered earlier and so buttresses the utility value of error protection in helping to counter these negative after-effects.

Aside from their contribution to the question of ER-induced error protection, the pattern of the probe-trial error rates over the various Categories (Schematic 3) for the target-plus-distractor probe trials revealed an unexpected pattern (Fig. 2). We had surmised that distractor-activated probe trial responses (i.e., distractor repeat trials) would be more susceptible to faulty execution than would non activated probe outputs. The reverse was actually the case; responses related to distractor-occupied probe trial locations were used in error comparatively less often, especially when they were ER-protected (i.e., [1] & [2] vs. [3] & [4]; Schematic 3). What our speculation might have missed is the fact that the response inhibition mechanism routinely invoked to prevent unwanted response executions of event activated responses is very effective (i.e., automatic self-inhibition, Schlaghecken et al., 2007).
This possibility is consistent with the important role played by response inhibition in achieving proper selective responding. It is the last processing point (i.e., the ‘late’ filter [Deutsch & Deutsch, 1963]) where inappropriate response execution urged by unintended (automatic) distractor processing (i.e., escapes the ‘early’ filter in direct access situations) can be halted. Hence, the need for an effective response inhibition ability to deal with what seem to be unavoidable unintended response activations. It may be for this reason that older adults show no loss in the inhibitory after-effects in location-based tasks where these after-effects result from distractor response inhibition, suggesting the latter remains intact as we age (Lok, 2011).

The repelling influence of distractor-response execution resistance (ER), claimed above to protect against faulty probe-trial response selection, can also explain why significantly higher error rates are sometimes found for ignored-repetition (IR) than for Control trials (e.g., current results; Buckolz et al., 2008; Fitzgeorge & Buckolz, 2008). On IR trials, but not on Control trials, ER opposes the probe target response and when successful, a response selection error occurs. This repelling influence is revealed more clearly in the significant tendency of subjects to select against former distractor-related responses in favour of Control responses on free choice probe trials (Fitzgeorge et al., 2011; Lok, 2011).

*Target-repeat Trials and Practice*

Consistent with previous work, repeating a prime trial’s target, location and response components (target-repeat trial) yielded significantly faster probe trial reactions than did repeating the target alone (Control trial) [Buckolz et al., 2008; Fitzgeorge & Buckolz, 2008]. Repeating a location and a response produces a facilitative processing
impact, either singly or collectively, when the target is also reused. It was informative to see that this target-repeat latency benefit is not altered with extensive practice. Control trial processing is not hastened to the point where the advantage resulting from the re-use of location and/or response components is reduced or removed. Interestingly, what practice does not achieve, predictability, and the advance preparation that it engenders, does. The target-repeat trial RT advantage can be removed when the probe trial is highly predictable (Fitzgeorge & Buckolz, 2008).

GENERAL DISCUSSION

Like spatial negative priming (SNP), the inhibition-of-return (IOR) phenomenon (Posner & Cohen, 1984) is the result of an inhibitory after-effect; however, in the latter instance, it arises because of inhibition associated with automatic orientation to peripheral stimulations (i.e., orientation inhibition), rather than because of distractor-response inhibition (but see Coward, Poliakoff, & O’Boyle, 2004). Also like SNP, IOR reflects delayed reaction time to targets appearing at former distractor locations. Unlike SNP, though, IOR theorists have justified the existence of orientation inhibition by showing that it has a beneficial consequence in the form of improving the efficiency of the visual search through a static environment, by decreasing the likelihood of orientation returning to an already visited spatial position (e.g., Klein, 2000; Lupianez, Klein, & Bartolomeo, 2006; Rafal, Davies, & Lauder, 2006).

Following this lead, we looked for and discovered a positive outcome for the inhibitory after-effects resulting from distractor-response inhibition; specifically, we learned that the execution resistance (ER) feature of inhibited responses helps to protect them against faulty selection at a later point in time (probe trial). It may be that the
beneficial aspect of inhibitory after-effects in general resides in their influence on
selection errors, be this in terms of manual responses and/or orientation actions.
Confirmation that other inhibitory after-effect phenomena exhibit error protection ability,
such as those generated within identity-based tasks, using either visible (e.g., identity NP; May et al., 1995) or masked (negative compatibility effect; Schlaghecken et al., 2007) prime distracters, would strengthen the idea that this ability is pervasive. Naturally, the
utility of this error protection rests upon the degree to which the relevancy status of
locations remains consistent in the environment, since it is clear that relevancy reversals
(e.g., ignored-repetition trials) generate detrimental inhibitory after-effects that detract
from their helpful error protection contribution.

The discovery of an ER-induced error protection influence not only counters ER’s
detrimental after-effects to some extent, it contributes to whether we should be concerned
about inhibitory after-effect absence (i.e., due to aging, neural dysfunction, disease, etc.).
Until this discovery, the lack of inhibitory after-effects in location-based tasks could
actually be seen as positive since their only known processing outcomes were negative,
and providing the absence did not reflect a deficient response inhibition ability, or a
memory dysfunction. Now, in assessing the consequences of inhibitory after-effect loss,
one would have to consider the impact of a lack of error protection. Looking at aging
effects for example, this consideration might be pertinent for certain identity-based tasks
whose inhibitory after-effects disappear in older adults (e.g., Connelly & Hasher, 1993;
McAuliffe, Chasteen, & Pratt, 2006).

Turning to the Sessions data, both the detrimental and beneficial inhibitory after-
effects, and the facilitative after-effects (i.e., target-repeats) were, for the most part,
remarkably well preserved over extensive practice. This is understandable in terms of the former because distractor-response processing sequence (A→I→ER) producing such after-effects includes response inhibition. Because of its critical role in achieving selective responding, one would expect that response inhibition (i.e., the ‘late’ filter, or court of last resort when the input filter fails; Deutsch & Deutsch, 1983) would have to continue to be performed effectively, irrespective of how many times it was needed. However, it was possible that the usually related inhibitory after-effects caused by response inhibition could dissipate with practice, perhaps caused by a reduction in ER strength, for example. This did not occur. We need to still determine, however, whether inhibitory after-effects produced in other tasks, such as the inhibition of return, identity NP and the negative compatibility effect phenomena, also show persistence over extensive practice. It is possible that persistence only occurs for inhibitory after-effects caused, in whole or in part, by response inhibition, which is the basis for the persistence.

Finally, the present results do not speak to the merits of existing major NP theories since these theories do not explicitly comment on inhibitory after-effect longevity in a repetitive task, nor do they entertain the possibility of inhibitory after-effects yielding a positive outcome (e.g., Fox, 1995; Houghton & Tipper, 1994; May, Kane, & Hasher, 1995; Neill, 2007; Schlaghecken et al., 2007; Tipper, 2001). This general silence notwithstanding, it seems fair to maintain that the tacit assumption of existing NP theories is that the conditions that produce inhibitory after-effects would continue to do so, even as distractor processing experience continued. This assumption was not indisputable, however. For example, if practice reduced response inhibition difficulty/time in a way that in turn reduced ER degree, inhibitory after-effects could
have been greatly reduced or even removed with practice. The results here showed that this did not happen. Testing the longevity of inhibitory after-effects produced in other tasks (e.g., identity NP, the negative priming effect, inhibition-of-return) would be helpful in testing the breadth of this preservation feature.
REFERENCES


APPENDIX A

Probe-trial Button-press Error Percentages
Table A1

Probe-trial button-press error percentages as a function of 4 prime-probe trial pairs (Categories): Neither - both prime and probe locations are unoccupied, ER Protection - prime contains distractor, probe location is unoccupied, Provocation - prime location is unoccupied, probe contains a distractor, and Both - both prime and probe locations contained a distractor.

**Target-plus-distractor Probe Trial**

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<thead>
<tr>
<th>Session</th>
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<th>ER Protection</th>
<th>Provocation</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38.93 (7.7)</td>
<td>23.83 (6.2)</td>
<td>7.20 (3.9)</td>
<td>0</td>
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<td>2</td>
<td>26.10 (7.4)</td>
<td>26.10 (7.0)</td>
<td>1.67 (1.7)</td>
<td>2.77 (2.0)</td>
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<tr>
<td>3</td>
<td>32.65 (7.9)</td>
<td>26.52 (7.1)</td>
<td>7.08 (3.9)</td>
<td>0.42 (0.4)</td>
</tr>
<tr>
<td>4</td>
<td>44.43 (7.8)</td>
<td>27.23 (6.7)</td>
<td>7.77 (4.7)</td>
<td>0.57 (0.6)</td>
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<tr>
<td>5</td>
<td>33.87 (8.0)</td>
<td>19.47 (6.4)</td>
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</tr>
<tr>
<td>6</td>
<td>41.87 (7.9)</td>
<td>21.20 (6.4)</td>
<td>7.70 (3.8)</td>
<td>2.50 (1.8)</td>
</tr>
<tr>
<td>7</td>
<td>26.70 (7.0)</td>
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<td>1.93 (1.4)</td>
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<td>8</td>
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<td>11.00 (4.9)</td>
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<td>9</td>
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<td>1.10 (1.1)</td>
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<tr>
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<td>10.83 (5.0)</td>
<td>2.10 (1.7)</td>
</tr>
<tr>
<td>14</td>
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<td>27.03 (6.9)</td>
<td>3.33 (2.3)</td>
<td>1.67 (1.7)</td>
</tr>
<tr>
<td>Overall Means</td>
<td>35.64</td>
<td>25.57</td>
<td>7.27</td>
<td>1.03</td>
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**Target-only Probe Trial**

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</tr>
</thead>
<tbody>
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<td>53.70 (7.9)</td>
<td>16.30 (4.9)</td>
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<tr>
<td>2</td>
<td>63.83 (7.7)</td>
<td>19.50 (5.8)</td>
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<td>54.23 (7.6)</td>
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<td>34.13 (7.7)</td>
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</tr>
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<tr>
<td>13</td>
<td>58.37 (8.1)</td>
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</tr>
<tr>
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<td>28.57 (6.5)</td>
</tr>
<tr>
<td>Overall Means</td>
<td>53.60</td>
<td>22.59</td>
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</table>

Note: ( ) = standard error
APPENDIX B

The University of Western Ontario Research Ethics Board of Approval Notice
Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Eric Buckolz
Review Number: 15180S
Review Level: Delegated
Approved Local Adult Participants: 300
Approved Local Minor Participants: 0
Protocol Title: Properties of Inhibitory After-effects
Department & Institution: Kinesiology, University of Western Ontario
Sponsor: Natural Sciences and Engineering Research Council

Ethics Approval Date: July 13, 2011  Expiry Date: July 31, 2013

Documents Reviewed & Approved & Documents Received for Information:

Document Name  Comments  Version Date
Revised Study End Date  The study end date has been revised to July 30, 2013 to allow for project completion.

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB’s periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The UWO NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000041.


This is an official document. Please retain the original in your files.

The University of Western Ontario
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APPENDIX C

Glossary of Terms, Letter of Information, & Script
GLOSSARY OF TERMS

**Control (CO):** A probe target stimulus that appears at a previously unoccupied prime location.

**Execution Resistance (ER):** A property of distractor response processing that repels a subject from performing a just inhibited response.

**Ignored Repetition (IR):** A probe trial target stimulus that arises at a location previously occupied by a distractor event on the prime trial.

**Inhibitory After-effects (IAE):** Execution resistance exerts an influence on future processing thus causing these effects.

**Reaction Time (RT):** The length of time it takes a subject to respond to a stimulus in milliseconds (ms).

**Spatial Negative Priming (SNP):** Slower reaction times when responding to a target stimulus that arises at a location previously occupied by a distractor event (ignored-repetition [IR] trial) than when it appears at a recently unused location (control [CO]).

**Target Repetition (TR):** A probe trial target stimulus that appears at a location previously occupied by a target event on the prime trial.
LETTER OF INFORMATION

Project Title: Properties of Inhibitory After-effects

Introduction
You are being invited to participate in a research study. The purpose of this letter is to provide you with the information you need to render an informed participation decision.

Purpose of the Study
The purpose of the study is to extend our understanding of one aspect of cognitive ‘inhibitory after-effects’, which refer to those occasions where a current act of inhibition results in interference effects (i.e., delayed responding time, error production) upon future processing in which the inhibited events participate. Inhibition is synonymous with the term ‘prevention.’ It refers to preventing the processing of various stimuli or the execution of various responses that we do not wish to do.

Basic Procedures
If you agree to participate, you will be asked to react as quickly as possible to visual target stimuli presented on a computer screen while concurrently ignoring distractor events that may also be present. You will respond to the spatial location and/or the identity of stipulated target stimuli by pressing designated computer keyboard buttons. Both the accuracy (button press errors) and decision times (reaction times) associated with your manual button press responses will be recorded and analyzed.

The general purpose of this experimentation is to extend our understanding of cognitive inhibition, which relates to our ability to prevent the unwanted processing of visual (distractor) information and/or their associated responses.

Participation requires you to attend multiple testing sessions in laboratories located in Thames Hall. Specific laboratory testing times will be arranged by you in consultation with the Experimenter (Alex Stoddart) who can be contacted by email or by phone.

Risks Associated with Participation
There are no known or reasonably anticipated risks associated with participation.

Benefits
No personal benefits will necessarily follow from your participation. It is possible, however, that your experience with, and understanding of, reaction time type tasks, along with knowledge gained from a debriefing session where the results obtained and their implications are noted will be viewed by you as beneficial. Additionally, any discoveries that advance our understanding of ‘inhibitory after-effects’ as a result of your participation might be viewed by yourself as a benefit.

Confidentiality
Efforts will be made to ensure that your data cannot be linked to you personally by anyone other than the Experimenter. Code numbers assigned to your data files will not
identify you directly but will be linked to your name on a master sheet kept by the Experimenter on a password protected computer. Once experimentation has been completed, the master sheet will be destroyed. Henceforth, it will be impossible to associate any particular data with your identity.

The data files and the master sheet will be stored on separate, password-protected computers located in locked laboratory or office spaces that are accessible only to the Experimenter. Publications that might arise from the data collected will not identify you personally. The data files will be retained for 5 years in the event publication does not arise, or for 5 years after ‘on-line’ publication, and then deleted.

**Participation**

Participation in this study is voluntary. You may refuse to participate or withdraw from the study at any time without penalty. If you withdraw, any data collected to that point will be deleted and will not be used in the study.

**Debriefing**

Once all of the data collection has been completed, you may contact the Experimenter by email for an explanation of the purpose of the study, along with the preliminary findings obtained. A debriefing session will also take place in the laboratory once all of the data have been collected which you can attend. At that time, information dealing with your participation will be discussed (i.e., study purpose, group results and their preliminary interpretation). The timing of the debriefing session will be told to you after your last testing session, or you can later email the Experimenter for this information.

**Contact Information**

If you have any questions about this study, you can contact Dr. Eric Buckolz or Alex Stoddart.

If you have any questions about the conduct of this study or your rights as a research subject, you may contact the Office of Research Ethics, The University of Western Ontario by phone or by email.

You do not waive any legal rights by signing the Consent Form.

**This letter is yours to keep.**
SCRIPT

On the screen four lines will appear separated by a cross in the middle. The fixation cross is what you constantly want to focus on. Rectangles will flash above these lines. You want to respond to the green ones (targets), while ignoring the red rectangles (distractors). You can respond by pressing the letter that corresponds to its assigned location. So line 1 corresponds with “D”, line 2 corresponds with “V”, line 3 corresponds with “M” and line 4 corresponds with “L”.

Trials will appear in pairs, first the prime and then the probe. At the beginning of each pair you will hear a tone “beep” followed by the appearance for the four lines and cross. Once the cross appears this is where you should focus your attention. Always focus on the cross. Anytime a green rectangle appears, you want to respond with the correct button, again anytime a red rectangle appears you want to ignore it. Once you respond with the correct response, the rectangles will disappear and the next trial will start. There will be times when both the green and red rectangles appear, simply ignore the red & respond to the green.

After several trials something will pop up saying you deserve a break, to continue just press the space bar and the trials will resume. At the end, there will be a pop up saying “Congratulations you’re done.” You don’t have to do anything, just leave the computer and come and get me.

Two important things to remember: You want to respond as quickly as possible while minimizing errors, and you want to make sure that you don’t anticipate (don’t respond before the stimuli appear).

Any questions? We’ll do a few practice trials so you can get the hang of it (5 practice trials or until student has full understanding).
CURRICULUM VITAE

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Recreation & Dance) Major of the Year
November 2010

AAHPERD (American Alliance of Health, Physical Education,
Recreation & Dance) Finalist- Physical Education
Major of the Year
December 2009

CRCA (Collegiate Rowing Coaches Association)
National Scholar Athlete
June 2009

Outstanding Student in Physical Education Award
April 2009

Top Scholar Athlete (Highest GPA on Team)
2008-2010

Dean’s List (EMU)
2006-2010

National Scholars Scholarship (EMU)
2006-2010

Regents Scholarship (EMU)
2006-2010
Related Work and Teaching Experience

Teaching Assistant
The University of Western Ontario 2011-2013

KIN4482: Perceptual-motor Performance/Learning 11/05/2012
Delivered lecture on Motor Programs, approx. 50 students

KIN4482: Perceptual-motor Performance/Learning 09/19/2012
Delivered lecture on properties of Preparation, approx. 50 students

Student Teaching Experience 10/25/10-12/10/10
Sarah Banks Middle School, Walled Lake, Michigan 48390

Student Teaching Experience 9/07/10-10/22/10
Loon Lake Elementary, Walled Lake, Michigan 48390

Professor’s Student Assistant 09/07/09-12/13/09
PHED470 Assessment and Evaluation in PE, EMU

University Tutor 09/13/08-12/09/08
Tutored student with learning disabilities in Motor Development course

Fieldwork Observations 2008-2010
100+ hours of pre-student teaching at various schools and levels

Publications/Poster Presentations:


Affiliations

*Professional*
2013    Physical and Health Education (PHE) Canada
2012-2013  Canadian Society for Psychomotor Learning & Sport Psychology (SCAPPS)
2010-2011  Michigan Education Association
2009-2011  American Alliance for Health, Physical Education, Recreation, & Dance
2009-2011  Michigan Alliance for Health, Physical Education, Recreation, & Dance

*Academic*
2012-2013  International Student Affairs position; Kinesiology Graduate Board, UWO
2009-2010  Student Athlete Advisory Council (SAAC) Representative
2008-2010  Eastern Michigan University’s Physical Education Organization (PEO)