



HAL
open science

Playing “guess who?”: When an episodic specificity induction increases trace distinctiveness and reduces memory errors during event reconstruction

Rudy Purkart, Jordan Mille, Rémy Versace, Guillaume Vallet

► To cite this version:

Rudy Purkart, Jordan Mille, Rémy Versace, Guillaume Vallet. Playing “guess who?”: When an episodic specificity induction increases trace distinctiveness and reduces memory errors during event reconstruction. *Memory*, 2022, 30 (5), pp.505-518. 10.1080/09658211.2021.2014527 . hal-03683591

HAL Id: hal-03683591

<https://hal.science/hal-03683591>

Submitted on 25 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Playing "Guess who?": When an Episodic Specificity Induction increases trace distinctiveness and reduces memory errors during event reconstruction.

Journal:	<i>Memory</i>
Manuscript ID	MEM-OP 21-99.R3
Manuscript Type:	Original Paper
Date Submitted by the Author:	n/a
Complete List of Authors:	PURKART, Rudy; Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal MILLE, Jordan; Université Clermont Auvergne, Laboratoire de Psychologie Sociale et COgnitive (LAPSCO - CNRS UMR 6024) VERSACE, Remy; Université Lumière Lyon 2, Laboratoire d'Étude des Mécanismes Cognitifs (EMC) VALLET, Guillaume; Université Clermont Auvergne, Laboratoire de Psychologie Sociale et COgnitive (LAPSCO - CNRS UMR 6024)
Keywords:	episodic specificity induction, constructive memory, memory errors, sensorimotor simulation, trace distinctiveness

SCHOLARONE™
Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 **Title:** Playing "Guess who?": When an Episodic Specificity Induction increases trace
4
5 distinctiveness and reduces memory errors during event reconstruction.
6
7
8
9

10 **Running Head:** Induction reduces memory errors.
11
12
13

14 **Authors:** Rudy PURKART^{1,*}, Jordan MILLE^{2,*}, Rémy VERSACE³ & Guillaume T. VALLET²
15
16
17

18
19 ¹Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal (CRIUGM),
20
21 Université de Montréal.
22

23
24 ² Laboratoire de Psychologie Sociale et Cognitive (LAPSCO – UMR CNRS 6024), Université
25
26 Clermont Auvergne.
27

28
29 ³ Laboratoire d'Étude des Mécanismes Cognitifs (EMC – EA 3082), Université Lumière Lyon 2
30

31 *These authors contributed equally to this work
32
33
34

35 **Correspondence:**
36

37 Rudy PURKART
38

39 rudy.purkart@criugm.qc.ca
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Abstract:

The constructive nature of memory implies a possible confusion between details of similar events. Memory interventions should thus target the reduction of memory errors. We postulate that a brief intervention called Episodic Specificity Induction (ESI) facilitates the sensorimotor simulation of event-related details by improving the distinctiveness of the event memory trace. As such, ESI should reduce memory errors only when event memory traces are strongly overlapping based on their sensorimotor features. Participants memorized videos showing characters performing an action on a given object. The characters were either visually very similar to each other or very distinct (low vs. high distinctiveness condition). Next, participants performed either an imagination version of the ESI or a control induction. Finally, a voice announced one of the actions seen and a character was then briefly displayed. The participants had to indicate whether the association was correct. For incorrect associations, in the low distinctiveness condition, false alarms were more likely than in the high distinctiveness condition and were reduced after the ESI. It suggests that facilitating the simulation of specific details through the ESI increased trace distinctiveness and reduced memory errors at the critical time of event reconstruction. Future clinical applications might be possible.

Keywords: *episodic specificity induction, constructive memory, memory errors, sensorimotor simulation, trace distinctiveness.*

INTRODUCTION

Less than a century ago, Bartlett (1932) rejected the idea that episodic memory passively and faithfully replays memories of past events, leading to the development of a more dynamic and constructive conception of memory. This conception is now widely accepted and suggests that episodic memory dynamically reconstructs memories of past events (see Schacter & Addis, 2007a, 2007b; Surprenant & Neath, 2009; Versace et al., 2009, 2014) by recombining specific pieces of information (or details) about the event (see the Constructive Episodic Simulation Hypothesis, Schacter & Addis, 2007a, 2007b). Nevertheless, the downside of a flexible and dynamic recombination of memories is that memory distortions become an inherent part of memory (i.e., the details of different events become confused; see Schacter et al., 2011; Schacter & Coyle, 1995). Memory distortions can have serious consequences in everyday life as well as in eyewitness testimony (e.g., Loftus & Palmer, 1996; see also Loftus & Palmer, 1974). For instance, an eyewitness can confuse a criminal with an innocent. Consequently, in a dynamic conception, memory performance depends on how accurate the reconstruction of memories is, and thus on the specificity of the details recalled in relation to the event, more than on the quantity of details recalled. It is therefore vitally important to develop effective interventions to reduce memory distortions and to improve the ability to access specific and correct details during reconstruction (for similar concerns, see Thakral et al., 2019). A constructive conception implies that such interventions can subsequently act not only at the time the memories are created but, above all, at the time they are accessed and reconstructed. The present study tests whether the benefits of such interventions occur only when the memory trace of the event to be reconstructed strongly overlap with the memory traces of similar events at the level of their sensorimotor features, as overlapping features (or details) do not contribute to the specific reconstruction of the event and may cause memory distortion.

Episodic Specificity Induction

A recently developed intervention called the *Episodic Specificity Induction* (ESI; Madore et al., 2014, 2019) has been shown to improve the (re)construction of past and future events. This intervention is based on a procedure known as the Cognitive Interview (Fisher & Geiselman, 1992; for a review, see Memon et al., 2010). In the study conducted by Madore et al. (2019), participants began by generating five experienced specific events (that took place in one place on one day) and giving each event a setting, a person, an object, and a title. After a filler task, participants were given one of three inductions before performing the main task. The 'memory' version of the ESI consisted of giving participants the title and three details (i.e., a setting, person, and object) of one of their generated events and helping them to remember the event by encouraging them to form a clear mental picture of the scene with eyes closed and to describe the event in as much detail as possible (what people looked like and did, how objects were arranged and looked, and so on). The 'imagination' version of the ESI consisted of giving participants three details from different generated events and helping them to imagine a new event that could happen to them in the near future with the three details, using the same instructions as the 'memory' induction. The control induction consisted of giving participants math problems to complete. After the induction phase, participants completed the main task which was an adapted version of the Autobiographical Interview (see Gaesser et al., 2011; Madore et al., 2014; see also Levine et al., 2002) and consisted of asking participants to 1) remember and describe in detail an actual past event related to a picture cue (memory task); 2) imagine and describe in detail a plausible future event related to a picture cue (imagination task); or 3) describe in detail the content of a picture cue (picture description task). It was shown that compared to the control induction, both the memory and imagination versions of the ESI induced an increase in the number of specific details (e.g., sensorimotor and phenomenological details specific to the described event) produced in the subsequent memory and imagination

1
2
3 tasks but not in the picture description task. Accordingly, these results suggests that the ESI
4
5 affect primarily the process of (re)constructing an event (past or future) rather than a
6
7 reproductive retrieval process that require remembering the details of an actual past event. Such
8
9 a constructive process is thought to be involved both when remembering and imagining an
10
11 event (see Schacter & Addis, 2007a, 2007b) and to ensure the recombination of the details of a
12
13 past event to construct it, or of several past events to construct an imaginary one. Consistently,
14
15 several studies report evidence of overlapping neural and cognitive processes that support
16
17 remembering past events and imagining future events (Mullally & Maguire, 2014; Schacter et
18
19 al., 2012) thereby claiming the constructive nature of memory. However, the basic mechanisms
20
21 underlying the event (re)construction process that are targeted and facilitated by the ESI remain
22
23 elusive. Among the candidates is the sensorimotor simulation mechanism.
24
25
26
27
28
29
30

31 *Sensorimotor simulation*

32
33 Recently, Purkart et al. (2019) proposed that sensorimotor simulation could be a key
34
35 mechanism underpinning the event (re)construction targeted and facilitated by the ESI.
36
37 Simulation is a reenactment of the brain states that occur while experiencing events (Barsalou,
38
39 2008, 2009). For instance, when we see a picture of our 18th birthday cake, the brain areas
40
41 specifically activated at the time of blowing out the candles during our 18th birthday party can
42
43 be activated and sensorimotor features specific to this event can be simulated (e.g., the smell of
44
45 the candles, the birthday song, etc.). Thus, reconstructing a specific past event would mean
46
47 simulating its specific sensorimotor features. As simulation takes place in the sensorimotor
48
49 areas of the brain, occupying these areas at the time of simulation (e.g., by displaying an
50
51 interfering visual stimulus) interferes with the simulation and preactivating these areas
52
53 facilitates the simulation (for related evidences in different sensorial modalities, see Brunel,
54
55 2013; Brunel et al., 2010, 2013; Dabic et al., 2018; Rey et al., 2015; Riou et al., 2015; Vallet et
56
57
58
59
60

1
2
3 al., 2010; Vallet, Hudon, et al., 2013; Vallet, Simard, et al., 2013; Yee et al., 2013).
4
5 Consequently, if the ESI targets and facilitates sensorimotor simulation, displaying an
6
7 interfering visual stimulus should reduce the ESI-related benefits on event construction. Purkart
8
9 et al. (2019) used a dynamic visual noise (DVN; McConnell & Quinn, 2004) as an interfering
10
11 stimulus during a video recall task which was preceded by an ESI or a control induction. The
12
13 DVN was supposed to occupy the visual areas solicited by the simulation of the specific visual
14
15 features of the videos to be recalled and disrupt this simulation. They found that the benefits of
16
17 the ESI for the generation of specific details in the subsequent video recall task were suppressed
18
19 when the DVN was presented during recall, unlike the presentation of a visual control stimulus.
20
21 This suggests that the ESI induces a facilitation of sensorimotor simulation of event-specific
22
23 features, thus resulting in an increased solicitation of sensorimotor areas involved in this
24
25 simulation (in this case, the visual areas in particular), except when these areas are already
26
27 occupied by the processing of the DVN. Sensorimotor simulation therefore appears to be a key
28
29 mechanism in event reconstruction that is targeted by the ESI. This hypothesis is not
30
31 inconsistent with the hypothesis proposed by Madore et al. (2019) that if the ESI primarily
32
33 reflects an influence on constructive retrieval processes, the downstream effects of the ESI
34
35 should be observed on memory and imagination tasks (but not on a picture description task)
36
37 after constructing an imagined future event during the ESI. Indeed, these tasks are both thought
38
39 to rely on the (re)construction of an event notably through access to event-specific details, as
40
41 opposed to the picture description task. However, multiple trace memory models (e.g.,
42
43 Activation-Integration model ; Versace et al., 2009, 2014) argue that access to event-specific
44
45 details proceeds from the simulation of event-specific sensorimotor features and is just as
46
47 necessary when imagining an event as when remembering it. To our knowledge there is no
48
49 sufficient evidence to rule out either hypothesis, but the observation reported by Purkart et al.
50
51 (2019) that an interfering visual stimulus suppresses the ESI-related benefits is sufficient to
52
53
54
55
56
57
58
59
60

1
2
3 suggest that sensorimotor simulation could be one of the key mechanisms underpinning the
4
5 event (re)construction targeted and facilitated by the ESI. The dynamics of this mechanism have
6
7 been described in detail in the Activation-Integration model (Act-In; Versace et al., 2009, 2014)
8
9 as a function of the similarity of the events. This model helps to understand the simulation
10
11 dynamic involved in inaccurate reconstructions and memory distortions and points the way to
12
13 the use of appropriate palliative interventions.
14
15
16
17
18

19 *Act-In: a multiple trace model*

20
21 According to the Act-In model (Versace et al., 2009, 2014), all sensorimotor experiences
22
23 are accumulated in the form of memory traces in our cognitive system. These traces reflect the
24
25 brain states specific to each experience and their different sensorimotor features (or details).
26
27 The more overlapping the memory traces are, the more likely it is that the overlapping features
28
29 will be simulated at the expense of their specific features. This would reduce the weight of
30
31 specific features and would therefore be detrimental for specific reconstruction and
32
33 consequently increase memory errors (e.g., simulating a detail that is not specific to the memory
34
35 being reconstructed; see Howe, 1998; Lyle & Johnson, 2006). Conversely, when memory traces
36
37 are highly distinct from one another (i.e., when they share very few details), the simulation of
38
39 features specific to a single trace should be facilitated, and the reconstruction should therefore
40
41 be more accurate. The proportions of memory errors should therefore be lower in this situation.
42
43 The probability of committing memory errors is therefore a function of the distinctiveness of
44
45 the memory traces, which is itself determined by the degree of overlap between memory traces
46
47 (see Brown et al., 2007; Ekstrom & Yonelinas, 2020; Surprenant & Neath, 2009). As a result,
48
49 facilitating the simulation of features specific to a given trace by means of the ESI should
50
51 increase the distinctiveness of the trace. This should reduce the probability of committing
52
53 memory errors. However, this benefit should only be observed when the traces strongly overlap
54
55
56
57
58
59
60

1
2
3 than when they are very distinct. Therefore, manipulating the similarity between events to be
4 reconstructed (i.e., the degree of overlap between memory traces) should reveal whether
5
6 facilitating the simulation of trace-specific features (by the ESI) reduces memory errors in the
7
8 low distinctiveness (or strong overlap) condition.
9
10

11
12 However, it is noteworthy that the ESI has been shown to increase memory errors
13 (recall of critical lures) in the DRM paradigm (Deese-Roediger-McDermott; Deese, 1959;
14 Roediger & McDermott, 1995; see Thakral et al., 2019). But although this paradigm is central
15 to the study of memory errors, the memory errors produced in this paradigm are not related to
16 some other memory errors produced in other paradigms (e.g., in misinformation paradigm, see
17 Calvillo & Parong, 2016; Ost et al., 2013; in semi-autobiographical false news story tasks, see
18 Patihis, 2016; for relation between DRM false memories and autobiographical rich false
19 memories, see Clancy et al., 2000; Meyersburg et al., 2009). Furthermore, the ESI has never
20 been applied, to the best of our knowledge, in paradigms other than DRM to determine whether
21 or not it could influence memory errors. Therefore, studying the effects of the ESI on memory
22 errors produced by the perceptual similarity between novel events to be reconstructed (in a
23 different paradigm, richer and more ecological material than in the DRM) should be informative
24 and provide insight to whether facilitating the simulation of specific details (by the ESI
25 according to our hypothesis) reduces the memory errors elicited in a high similarity condition.
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

47 **The present study**

48
49 Memory trace distinctiveness was manipulated in the present study by creating several videos
50 showing characters performing an action on a given object. Perceptual similarity varied
51 between the characters in a block of 4 videos (one character per video): for half of the blocks,
52 the characters in each block shared a large number of features (LOW DISTINCTIVENESS
53 condition), and for the other half they shared very few features (HIGH DISTINCTIVENESS
54
55
56
57
58
59
60

1
2
3 condition). Each video was associated with an audio track of a voice describing the action on
4 the object performed by the filmed character (e.g., “Sitting on a chair”). Participants took part
5 in each of the two sessions of the experiment, which were identical except for the material
6 studied and the induction received. Each session included a study phase, an induction phase,
7 and a test phase. In the study phase, participants had to watch and memorize the videos (who
8 did what action with what object). Each participant watched as many blocks of the LOW
9 DISTINCTIVENESS condition as of the HIGH DISTINCTIVENESS condition, in order to
10 manipulate the « Distinctiveness » factor (i.e., the first independent variable) as a within-subject
11 factor. After the study phase, in the induction phase, participants performed an ESI or a control
12 induction in a counterbalanced manner, in order to manipulate the « Induction » factor (the
13 second independent variable) as a within-subject factor. In the subsequent test phase, only the
14 audio tracks of the videos were played again, each of them being followed by a photograph of
15 a character that the participants had to judge, as quickly and accurately as possible, if it matches
16 exactly the character who performed the action (for MATCH trials), or if it does not match (for
17 MISMATCH trials). Each participant completed as many MATCH trials as MISMATCH trials.
18 The dependent variables were hit rates (i.e., correct responses rates for MATCH trials), false
19 alarm rates (i.e., errors rate for MISMATCH trials), and response times.

20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42 In accordance with Act-In (and with other models, see for instance the SIMPLE model,
43 e.g., Surprenant & Neath, 2009) highly similar events should lead to strongly overlapping
44 memory traces and should be associated with more memory errors. Listening to the audio track
45 should trigger a simulation of the action in question on the object associated with a character,
46 and this simulation should be all the more specific to a character, the more distinct it is from
47 the others. Thus, if the test character is different from the simulated character (MISMATCH
48 trials), the responses should be more accurate (and quicker) in the HIGH DISTINCTIVENESS,
49 because this trial type require to access distinctive features to avoid false alarms. If the test
50
51
52
53
54
55
56
57
58
59
60

1
2
3 character is identical to the simulated character (MATCH trials), then its distinctiveness should
4
5 not matter, because this trial type does not require to discriminate the characters from each
6
7 other, but instead require finding a match between the test character and the simulated character.
8
9
10 In addition, if the ESI, by facilitating the simulation of trace-specific features, increases trace
11
12 distinctiveness, it should only be beneficial in reducing memory errors (i.e., false alarms) in
13
14 MISMATCH trials. However, since the overlap between traces is already low in the HIGH
15
16 DISTINCTIVENESS condition, the ESI should only reduce false alarms in the low
17
18 distinctiveness condition.
19
20
21
22
23

24 **EXPERIMENT**

25 **Materials and Method**

26 *Participants*

27
28
29
30 Prior to the experiment, we decided that at least 24 participants would be sufficient for
31
32 observing a medium-sized effect (i.e., $f=0.25$) if it exists (power $> .80$, two-tailed, for a within-
33
34 subjects design; see Faul, Erdfelder, Lang, & Buchner, 2007). This sample size is consistent
35
36 with prior ESI-related studies that have used this number (e.g., Madore et al., 2014, 2015). In
37
38 order to anticipate possible exclusions, data collection was stopped at 38 participants. As no
39
40 participants were excluded, 38 young adults ($M_{\text{age}} = 21.02$ years, $SD_{\text{age}} = 1.55$, $\text{range}_{\text{age}} = 19-$
41
42 27, 35 female) took part in the study. They were recruited by means of advertisements at Lyon
43
44 2 University. All the participants had normal or corrected-to-normal vision and audition, and
45
46 no history of neurological or psychiatric disorders. All the participants were French native
47
48 speakers.
49
50
51
52
53
54
55

56 This study was carried out in accordance with the recommendations of French Law (Loi Jardé
57
58 n°2012- 300), with written informed consent being obtained from all the subjects in accordance
59
60

1
2
3 with the Declaration of Helsinki. An ethics approval was issued for the current study by the
4
5 ethics committee of Clermont Auvergne University (IRB00011540-2019-43). This study was
6
7 not pre-registered. Materials are available on demand.
8
9

10 11 12 ***Material***

13 14 Character/Action Videos

15
16 *Characters* – Fourteen blocks (2 practice blocks, 12 experimental blocks) of 4 characters each
17
18 were created using The Sims 4™ video game (Figure 1). For half of the blocks assigned to the
19
20 "LOW DISTINCTIVENESS" condition, the characters in each block were designed to be
21
22 "LOW DISTINCTIVENESS" condition, the characters in each block were designed to be
23
24 visually lowly distinct from each other. For the other half of the blocks assigned to the "HIGH
25
26 DISTINCTIVENESS" condition, the characters in each block were designed to be visually
27
28 highly distinct from each other. The distinctiveness of the characters in each block was
29
30 configured on the basis of 11 dimensions: gender (man vs woman), build (heavy vs light), skin
31
32 color (blue, red, green, or yellow), age (child vs adult), hair color (blond, brown, ginger, or
33
34 white), head covering (beanie, beret, cap, or hat), glasses (with vs. without), sleeve length (short
35
36 vs long), pant length (short vs long), shoes (sneakers vs flip-flops), and faces. Within each block
37
38 in the LOW DISTINCTIVENESS condition, the modalities of 5 dimensions (gender, build,
39
40 skin color, age, hair color) were identical for the 4 characters of a given block. For the 6
41
42 remaining dimensions, the modalities were pseudorandomized across the 4 characters within
43
44 the block as follows: for a 2-modality dimension, two characters shared the same modality,
45
46 while for a 4-modality dimension, one character was assigned to each modality. Within each
47
48 block in the HIGH DISTINCTIVENESS condition, the modalities of all 11 dimensions were
49
50 pseudorandomized across the 4 characters within the block. In this condition, only two (not
51
52 four) modalities of the skin color dimension were assigned in each block. The face of each
53
54 character was systematically different in both conditions. No character had the same
55
56
57
58
59
60

1
2
3 configuration of modalities as any another character (out of the 260 possible configurations).
4
5 Of the 14 blocks created, two blocks (one in each condition) were selected for practice after
6
7 changing their skin color modality to black, white, and brown. A photograph was taken of each
8
9 character.
10

11
12
13
14
15 **[Insert Figure 1.]**

16
17 **Figure 1.** Photographs of the characters in a block in each distinctiveness condition.
18

19
20
21 *Actions* – Twelve different types of action were selected (e.g., sitting on, playing, etc.) using
22
23 The Sims 4™ video game. For each type of action, 4 objects were selected on which the
24
25 corresponding actions were performed (e.g., a chair, a stool, a bench, an armchair). Within each
26
27 block, the four characters performed the same action but on a different object. The association
28
29 between actions and distinctiveness condition (high vs. low) was counterbalanced in a between-
30
31 subjects manner across two lists (A vs. B). For instance, the "Sitting on__" action was presented
32
33 in the LOW DISTINCTIVENESS condition for half of the participants, while this action was
34
35 presented in the HIGH DISTINCTIVENESS condition for the other half. Two additional action
36
37 types and 8 matching objects were added for the practice blocks. List of actions and objects
38
39 available in the Appendix section (Table 2).
40
41
42
43
44
45
46

47
48 *Videos* – Using The Sims 4™ video game, 48 videos were generated and recorded for action
49
50 list A (one for each character) and 48 were recorded for action list B. Eight additional videos
51
52 were recorded for the practice blocks. Each video started with a full shot of the motionless
53
54 character presented in front of the camera for approximately 1 second. Then the character
55
56 moved towards the spectator in the direction of the object, currently out of the camera's range.
57
58 The camera tracked the character's movement, while remaining in front of it, for approximately
59
60

1
2
3 3 seconds. The object appeared in the camera's range at the end of the character's movement
4 and to the right of it. Finally, the character performed the action on the object for approximately
5
6
7 3 seconds. The scene took place in an empty room with gray walls and floor. On the floor, a
8
9 path between two blue stripes was systematically visible and used by the character. The average
10
11 length of the videos was 7.52 seconds ($SD = 1.20$).
12
13
14
15
16

17 *Audio* – For each object, an audio recording was created using Balabolka 2.11 in which a virtual
18 female voice pronounced the type of action followed, after a short pause, by the name of the
19 object (e.g., "Sitting on__a CHAIR"). Forty-eight audio tracks were recorded. Eight additional
20
21 audio tracks were recorded for the practice blocks.
22
23
24
25
26
27

28 Inductions

29
30 *Stimulus Collection Task* – Five familiar places, persons and objects were collected on a piece
31 of paper for each participant. The familiarity of each item was evaluated by the participants on
32 a scale going from 1 (not familiar at all) to 9 (very familiar). Next, the most familiar place,
33 person and object were selected for the ESI.
34
35
36
37
38
39
40
41

42 *Episodic Specificity Induction* – The ESI used was a French version of the imagination
43 specificity induction designed by Madore et al. (2019). It consists of a script with the help of
44 which the experimenter uses various techniques to help the participant imagine an event
45 involving the most familiar place, person and object selected during the stimulus collection
46 task. This script is divided into three phases of imagination and detailed description, which
47 focus respectively on the environment (the objects in the environment, their appearances, their
48 locations, etc.), the people, and the actions performed in the imagined event. In each phase,
49 participants are asked to close their eyes and mentally visualized the elements as clearly as
50
51
52
53
54
55
56
57
58
59
60

1
2
3 possible. After forming the clearest possible picture in their mind, participants then described
4 these elements in as much details as possible. At the end of each phase, the experimenter asked
5 the participants to provide more details on the elements that have been superficially described.
6
7 For a more detailed description of the ESI, see Madore et al. (2019). The imagination version
8 was chosen over the standard version (which involved memorizing and recalling a video in
9 detail as in Madore et al., 2014) to reduce the likelihood that participants would comply by
10 guessing that the ESI was to help them remember the videos being studied, and/or consciously
11 re-using the ESI techniques to remember the videos being studied.
12
13
14
15
16
17
18
19
20
21
22
23

24 *Control Induction* – This consisted of several short, simple mathematical exercises including
25 addition, subtraction, multiplication and division.
26
27
28
29
30
31
32

33 *Procedure*

34
35 The participants were asked to sit in front of a laptop (LENOVO ThinkPad L470 - Windows
36 10 Pro 64 bits - 16GB RAM - 464 GB DD). After signing the consent form indicating their
37 agreement to take part in an experiment designed to test their memory, they completed the
38 Stimulus Collection Task sheet by specifying 5 familiar places, people and objects and rating
39 their familiarity on a scale going from 1 (not at all familiar) to 9 (very familiar). The participants
40 were then told that the experiment would begin with a practice session, followed by two
41 sessions (approx. 25 min. each) separated by a break (approx. 5 min.). Each session started with
42 a study phase (approx. 8 min.), followed by a filler task (which actually corresponded to the
43 induction phase; approx. 10 min.) and finally a test phase (approx. 8 min.). Each session is
44 described below. The total duration of the experiment was approximately one hour. Figure 2
45 illustrates the experimental procedure.
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 *Session one*
6

7
8 For the study phase, the participants were told that, in each trial, they would first see a fixation
9
10 cross (400 ms) and then hear, via their headphones, a voice saying an action and an object name,
11
12 while they simultaneously watched a video featuring a character performing the action on the
13
14 object. The participants were asked to pay attention during each trial and to memorize what the
15
16 voice said, the appearance of the character, the type of action performed, and the object on
17
18 which the character performed the action, as they would need to remember this information
19
20 later in the test phase. They were warned that some characters may look very similar, but that
21
22 each video would involve a different character. They were encouraged to press the space bar
23
24 within 3 seconds of the end of each video in order to move on to the next one. The participants
25
26 saw the videos of 3 LOW and 3 HIGH DISTINCTIVENESS blocks (24 videos in total) and
27
28 simultaneously heard the corresponding audio track for each video. Two blocks from the same
29
30 condition never followed each other. The presentation order of the blocks and the association
31
32 between the actions and the distinctiveness conditions (list A vs. B) were counterbalanced
33
34 across participants. After the study phase, the participants started the induction phase (instead
35
36 of the filler task).
37
38
39
40
41
42
43
44

45 In the induction phase, the participants were assigned to the ESI or Control condition based on
46
47 the odd or even number attributed to them. In the ESI condition, they were told that they were
48
49 taking part in an imagination exercise. The experimenter asked them to imagine an event that
50
51 would take place in the selected familiar place, in the company of the selected familiar person,
52
53 and where they would interact with the selected familiar object. They were told that the
54
55 experimenter would help them in this exercise by giving them some instructions and that they
56
57 would proceed in stages, focusing first on the description of the place, then on the person, and
58
59
60

1
2
3 finally on the imagined actions (see Madore et al., 2019 for full instructions). In the Control
4
5 condition, the participants were asked to complete a series of simple mathematical exercises as
6
7 quickly as possible, while making as few errors as possible. The duration of each induction
8
9 phase for each participant was identical from one session to another (10 minutes). After the
10
11 induction phase, the participants started the test.
12
13
14
15
16

17 For the test phase, the participants were told that in each trial, one of the audio tracks from the
18
19 study phase (a voice saying an action and an object name) would be replayed while a neutral
20
21 gray background was displayed on the screen for 3,000 ms. They were told that this would be
22
23 followed by a photograph of a character from the study phase displayed in the center of the
24
25 screen for 1,000 ms on a black background before the gray background was displayed again,
26
27 with this then remaining on screen until the participant responded (or until the 4,000 ms
28
29 timeout). The Inter-Trial Interval (ITI) was set to 2,000 ms. The participants were told to
30
31 indicate as soon as the character was displayed, and as quickly and accurately as possible,
32
33 whether the character displayed matched exactly the character who had performed the action
34
35 on the specific object they had previously seen (in the study phase). To do this they had to press
36
37 one key to answer MATCH, or press another key to answer MISMATCH. They were told that
38
39 none of the characters displayed were new and that they had all been seen in the study phase.
40
41 For the MISMATCH trials, the displayed character was from the same block and had performed
42
43 the same action, but not on the same object, as the target character who had performed the
44
45 action on the object mentioned in the audio track. For the MATCH trials, the character was the
46
47 same as the character who had performed the action on the object mentioned in the audio
48
49 description. The characters were presented only once either in MISMATCH trials or in
50
51 MATCH trials. For the 24 trials, the correctness of the association between the audio track and
52
53 the following character in each distinctiveness condition was pseudo-randomized. The
54
55
56
57
58
59
60

1
2
3 presentation order of these associations was randomized for each participant. For half of the
4 trials, the associations were correct and required a MATCH response (i.e., the MATCH trials),
5 while for the other half, the associations were incorrect and required a MISMATCH response
6 (i.e., the MISMATCH trials). Accuracy and response times for each trial were collected. After
7 the test phase, there was a 5-minute break before starting the second session. The participants
8 discussed their academic background with the experimenter during this break to prevent them
9 from thinking about the experiment.
10
11
12
13
14
15
16
17
18
19
20

21 *Session two*

22
23 The second session was strictly identical to the first, except that the participants saw the videos
24 that they had not seen in the first session and performed the induction that they had not already
25 been subjected to (ESI or Control). The material used was counterbalanced across sessions and
26 inductions, and the order of inductions was counterbalanced across the participants and the
27 sessions.
28
29
30
31
32
33
34
35
36

37 *Practice session*

38
39 The first session was preceded by a practice session which consisted of a practice study phase
40 of 8 practice trials (with the dedicated material), immediately followed by a practice test phase.
41 There was no interval between the two practice phases as no induction was performed, unlike
42 in sessions one and two. For the practice "study phase", the first 4 practice trials consisted in
43 successively presenting the videos of the 4 characters from the LOW DISTINCTIVENESS
44 practice block together with the corresponding audio tracks, while the next 4 practice trials
45 consisted in presenting the videos of the 4 characters from the HIGH DISTINCTIVENESS
46 practice block. The instructions and the trial procedure for the practice study and test phase
47 were identical to those of the study and test phase of the experiment. Feedback (green circle or
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 red cross) indicating the participant's performance was only given for the practice test phase
4
5 and provided information as to whether the response was correct or not.
6
7
8
9

10 **[Insert Figure 2.]**

11
12 **Figure 2.** Schematic procedure of the experiment.
13
14
15
16

17 **Results**

18
19 Data were analyzed using RStudio version 1.2 (R Foundation for Statistical Computing). The
20
21 mean response times for correct responses (RT), the mean rates of hits (HITS; for the MATCH
22
23 trials) and the mean rates of false alarms (FA; for the MISMATCH trials) were computed across
24
25 participants for each experimental condition. RT exceeding 2,500 ms and 2.5 standard
26
27 deviations above each participant's mean in each condition and RT less than 300 ms and 2.5
28
29 standard deviations below each participant's mean per condition were considered as outliers
30
31 and removed from the analyses (less than 5%, see Vallet et al., 2010 for a similar procedure).
32
33 Because the expected results focus on the participants' ability to correctly reject incorrect
34
35 character-action associations (or to avoid false alarms) in the "MISMATCH" trials, separate
36
37 analyses were conducted for each trial type, one for MATCH trials and one for MISMATCH
38
39 trials. For each trial type, two ANOVAs were performed, one on FA (or HITS) and the other
40
41 on RT. Each analysis was performed with "Induction" (ESI vs. Control) and "Distinctiveness"
42
43 (LOW DISTINCTIVENESS vs. HIGH DISTINCTIVENESS) as within-subject factors. Post-
44
45 hoc tests were performed using Tukey's method. The threshold of statistical significance for all
46
47 analyses was set to $p < .05$. Table 1 displays the descriptive statistics.
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 **Table 1.** Descriptive statistics (mean with standard deviation in parentheses) for each trial type
4 (match vs. mismatch) on the recognition task as a function of induction (ISE vs. control) and
5
6 distinctiveness (high vs. low).
7
8
9

10
11
12 **[Insert Table 1.]**
13

14 *Note. SD: standard deviation; ESI: Episodic Specificity Induction; RT are in milliseconds.*
15
16

17 18 19 **Hits.**

20
21 For the MATCH trials, the analysis only revealed a significant main effect of Distinctiveness
22 ($F(1, 37) = 8.51, p < .01, \eta^2_g = .05$), with lower HITS in the HIGH DISTINCTIVENESS
23 condition than in the LOW DISTINCTIVENESS condition. The main effect of Induction and
24 the interaction between these two factors were not significant ($F < 1$).
25
26
27
28
29

30 31 32 **False alarms.**

33
34 For MISMATCH trials, there was no main effect of Induction ($F < 1$) but a significant main
35 effect of Distinctiveness ($F(1, 37) = 48.96, p < .0001, \eta^2_g = .264$) with a large effect size, with
36 lower FA being observed in the HIGH DISTINCTIVENESS condition than in the LOW
37 DISTINCTIVENESS condition. The analysis also revealed a significant interaction between
38 Induction and Distinctiveness ($F(1, 37) = 6.35, p < .02, \eta^2_g = .022$). Post-hoc comparisons
39 showed lower FA after the ESI than after the Control Induction in the LOW
40 DISTINCTIVENESS condition ($t(73.1) = 2.08, p < .05, d = .40$), but not in the HIGH
41 DISTINCTIVENESS condition ($t(73.1) = -1.27, p = .21, d = .22$)(Figure 3).
42
43
44
45
46
47
48
49
50
51
52

53
54
55
56 **[Insert Figure 3.]**
57
58
59
60

1
2
3 **Figure 3.** Comparison of the mean rates of false alarms for the different Induction types
4 (Control vs. ESI) in each Distinctiveness condition (HIGH vs. LOW) for MISMATCH trials
5 (incorrectly endorsing the test character as the one who performed the action on the object
6 enounced). Gray bars represent standard errors corrected for the within-participant design.
7
8
9
10
11
12
13

14 *Response times.*

15
16 For the MATCH trials, the analysis only revealed a significant main effect of Distinctiveness
17 ($F(1, 37) = 6.48, p < .02, \eta^2_g = .02$), indicating that RT were faster in the HIGH
18 DISTINCTIVENESS condition than in the LOW DISTINCTIVENESS condition. The main
19 effect of Induction ($F(1, 37) = 1.94, p > .05, \eta^2_g = .006$) and the interaction ($F < 1$) were not
20 significant.
21
22
23
24
25
26
27
28
29

30 For the MISMATCH trials, the analysis only revealed a significant main effect of
31 Distinctiveness ($F(1, 33) = 7.92, p < .01, \eta^2_g = .03$), indicating that RT were faster in the HIGH
32 DISTINCTIVENESS condition than in the LOW DISTINCTIVENESS condition. The main
33 effect of Induction ($F(1, 33) = 1.53, p > .05, \eta^2_g = .006$) and the interaction ($F < 1$) were not
34 significant.
35
36
37
38
39
40
41
42
43
44

45 *Carryover.*

46 An additional ANOVA was conducted with the “Induction Order” as between-subject factor to
47 determine whether the false alarms rate differed as function of whether participants received
48 the ESI in the first session or in the second session (using the same parameters as the previous
49 analyses). The analysis revealed no significant main effects or interactions associated with
50 Induction Order on Hits ($F_s < 1$), FAs ($F_s < 1$), and RTs for MATCH trials ($F_s < 1$) and
51 MISMATCH trials ($F_s < 1$). The lack of any carryover effect is consistent with previous ESI-
52
53
54
55
56
57
58
59
60

1
2
3 related studies (e.g., Madore & Schacter, 2015; Purkart et al., 2019) and indicate that
4 participants performed similarly in the study irrespective of whether they received the ESI in
5 the first session or second session.”
6
7
8
9

10 11 12 **DISCUSSION** 13

14 The aim of the study was to determine situations in which the ESI, which is thought to
15 facilitate the access of trace-specific features (see Purkart et al., 2019) and increase trace
16 distinctiveness, might be effective in reducing memory errors. We predicted that the probability
17 of memory errors would be a function of trace distinctiveness. Specifically, for the
18 MISMATCH trials, correct responses should be slower and false alarms higher when the
19 distinctiveness between traces is low than when the distinctiveness is high. Therefore, we
20 expected to find that the beneficial effect of the ESI would only occur when distinctiveness was
21 low for the MISMATCH trials, because this trial type requires to access the specific features
22 that distinguish the correct character from the test character, unlike the MATCH trials in which
23 a simple matching procedure is required. Thus, neither the ESI nor trace distinctiveness should
24 play a role with regard to the MATCH trials.
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

42 *Distinctiveness and induction effects for MISMATCH trials* 43

44 As predicted, the participants responded more accurately and quickly in the high
45 distinctiveness condition than in the low distinctiveness condition when the test character was
46 different from the correct character (for the MISMATCH trials). When the characters were very
47 distinct (HIGH DISTINCTIVENESS condition), hearing the action sentence triggered the
48 activation of the specific features of the character who performed the action in question.
49 Therefore, since a large number of features differed between the correct character and the test
50 character in this condition, the participants were more likely to correctly judge the test character
51
52
53
54
55
56
57
58
59
60

1
2
3 as not being the character who performed the action in question (and to do so more quickly).
4
5 On the other hand, when the characters were very similar (LOW DISTINCTIVENESS
6
7 condition), hearing the action sentence triggered the activation of the overlapping features
8
9 (shared between the characters) at the expense of the specific features of the character who
10
11 performed the action in question. Therefore, since only a few features differed between the
12
13 correct character and the test character in this condition, the participants were more likely to
14
15 incorrectly judge the test character as being the character who performed the action in question.
16
17 Thus, the participants failed to identify the features of the test character that differed from those
18
19 of the character who actually performed the action. As a result, the inability to identify these
20
21 features made verification of the properties more time-consuming and slower in this
22
23 distinctiveness condition. The participants therefore responded less accurately and quickly in
24
25 the LOW than in the HIGH DISTINCTIVENESS condition.
26
27
28
29
30
31
32

33 Crucially, in the LOW DISTINCTIVENESS condition, the participants responded
34
35 more accurately after the ESI than after the control induction in the MISMATCH trials. The
36
37 access of the specific features of a given character appears to be facilitated by the ESI (see
38
39 Purkart et al., 2019). This effect is thought, in turn, to increase the distinctiveness of the trace
40
41 of the character performing the action, thereby increasing the participants' ability to reject the
42
43 proposed incorrect character. This result is noteworthy since it shows a reduction in memory
44
45 errors (expressed by false alarms) in a condition in which these errors were highly probable,
46
47 and thus points to improved memory efficiency. As such (and as expected), in the HIGH
48
49 DISTINCTIVENESS condition, in which the characters' memory traces were already
50
51 sufficiently distinct to make it possible to reject or recognize the character on the basis of its
52
53 specific features, the ESI did not prove to be beneficial.
54
55
56
57
58
59
60

1
2
3 One might ask why would ESI not improve the overall memory performance
4 independently of the distinctiveness condition? The rationale is that, as explained above,
5 participants responded less accurately and less quickly in the LOW than in the HIGH
6 DISTINCTIVENESS condition where the number of specific features is greater. As the
7 discrimination between an incorrect test character and a correct character is based on the
8 activation of the specific features that distinguish them, having many specific features to
9 activate facilitates discrimination. As such, since there are a low number of overlapping features
10 between characters in the HIGH DISTINCTIVENESS condition, the activation of specific
11 features is less limited than in the LOW DISTINCTIVENESS condition (which is consistent
12 with the Act-In model). The activation of specific features is therefore sufficiently important
13 for the ESI not to be of decisive help in the HIGH DISTINCTIVENESS condition. Reversely,
14 as there are many overlapping features between the characters in the LOW
15 DISTINCTIVENESS condition, the activation of specific features is more limited than in the
16 HIGH DISTINCTIVENESS condition. The activation of specific features is therefore
17 sufficiently affected for the ESI to be of decisive help in the LOW DISTINCTIVENESS
18 condition. Consequently, if the ESI improves trace distinctiveness, it is consistent that the ESI
19 has a beneficial effect in the LOW DISTINCTIVENESS condition and has no effect when the
20 distinctiveness is already high.
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

47 *Distinctiveness and induction effects for MATCH trials*

48
49 Nevertheless, and contrary to our predictions, the participants responded more
50 accurately in the low distinctiveness condition than in the high distinctiveness condition for the
51 MATCH trials (in contrast to the inverse result pattern observed for the MISMATCH trials).
52 Similar patterns of results were reported by Ozubko & Joordens (2008) who found a higher
53 proportion of correct recognitions (hits) and memory errors (false alarms) in a condition in
54
55
56
57
58
59
60

1
2
3 which the perceptual distinctiveness between characters was at its lowest (minimal feature
4 characters) compared to a condition in which perceptual distinctiveness between characters was
5 at its highest (normal feature characters). Our result could be attributed to a "generalization"
6 effect similar to that observed by Brunel et al., (2013). In this study, the authors showed that
7 the activation of a specific feature of a target item (e.g., its sound) during its recollection was
8 impeded if the target item was studied along with other items that are perceptually very similar
9 (in shape and color). This generalization effect was not observed when the other items were
10 more perceptually different. In our study, although the characters in the LOW
11 DISTINCTIVENESS condition were confronted with different objects (e.g., chair, stool,
12 armchair, bench), they nevertheless performed the same action (e.g., sitting on) and shared
13 many features (e.g., skin color, age, gender, build). The overlapping features of the characters
14 and the similarity of the action performed could have impeded the access of the distinctive
15 features, thus indicating a generalization effect. As a result, access to distinctive features was
16 still impeded and their verification was slower. However, contrary to the MISMATCH trials,
17 the responses in the MATCH trials were based on the similarities between the test and correct
18 characters. Since the participants found it more difficult and took longer to verify distinctive
19 features because the access of overlapping features was reinforced by the generalization effect,
20 the match between the test character and the correct character was enhanced, but only on the
21 basis of their overlapping features. Consequently, this generalization effect was beneficial in
22 this trial type because it facilitated the access of overlapping features and the judgment of
23 similarity between the simulated character and the test character. This would explain why, for
24 the MATCH trials, the participants responded more accurately, but still slowly, in the LOW
25 than in the HIGH DISTINCTIVENESS condition. However, and consistent with our
26 hypotheses, the ESI had no significant effect for the MATCH trials because facilitating the
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 access of specific features is unlikely to be beneficial in a condition in which the response is
4
5 based on a matching principle.
6
7
8
9

10 Reversely, since MISMATCH trials require access to distinctive features particularly in
11 the LOW DISTINCTIVENESS condition, it is consistent to found that the generalization effect
12 was detrimental, and the ESI beneficial in this trial type. Indeed, the ESI would have increased
13 trace distinctiveness by facilitating the access of specific features at the expense of overlapping
14 features. It would therefore be interesting to adapt the paradigm used by Brunel et al., (2013)
15 by isolating a character, who would perform an action different from that performed by the
16 other characters in a given block, and observing whether the ability to recognize the correct
17 action for the isolated character is negatively impacted by a condition of low distinctiveness
18 between characters compared to a condition of high distinctiveness. The generalization effect
19 should lead to the access of the action performed by non-isolated characters at the expense of
20 the action performed by isolated characters when they are perceptually similar, but not when
21 they are different. If the ESI does promote trace distinctiveness and reduce the generalization
22 effect, simulation of the action performed by the isolated character should be facilitated in the
23 low distinctiveness condition. This interpretation suggests that trace distinctiveness and
24 generalization can be seen as the two plates of a scale where the rise of one plate leads to the
25 fall of the other, which is consistent with the predictions of the Act-In model (Versace et al.,
26 2009, 2014).
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50

51 *Back to Act-In*

52 Act-In is a multiple trace model which states that all sensorimotor experiences are
53 accumulated in the form of memory traces in our cognitive system. These traces reflect the
54 brain states specific to each experience and their different sensorimotor features (or details).
55
56
57
58
59
60

1
2
3 Knowledge would emerge from a continuum according to the number of traces involved in the
4 simulation. For instance, the emergence of categorical knowledge (e.g., categorizing an animal
5 as a dog) is possible by simulating (or activating) the sensorimotor overlapping features of all
6 the traces where the individual has been confronted with a dog (high inter-trace activation
7 diffusion and intra-trace activation diffusion to overlapping features). The more the traces
8 overlap, the easier the diffusion of inter-trace activation would be (and the more limited the
9 diffusion of intra-trace activation would be). On the other hand, the emergence of specific
10 knowledge (e.g., the memory of the day I adopted my dog) is possible through the
11 simulation/activation of the features specific to the trace of the adoption event (low inter-trace
12 activation diffusion and intra-trace activation diffusion to the trace-specific features). The more
13 distinct the traces are, the easier the diffusion of intra-trace activation would be (and the more
14 limited the diffusion of inter-trace activation would be). Thus, according to Act-In, there is an
15 activation “scale” between inter-trace and intra-trace diffusion, and inter-trace diffusion would
16 be detrimental for intra-trace diffusion and vice versa. The generalization effect (observed in
17 the LOW DISTINCTIVENESS condition in the present study) would emerge from an inter-
18 trace diffusion facilitated by the overlap between the traces, which limits intra-trace diffusion
19 to the specific components. In this case, participants are not able to discriminate the test
20 character from the simulated character on the basis of its specificities. Thus, according to Act-
21 In, the ESI facilitates the simulation of the specific features of the simulated character by
22 facilitating intra-trace diffusion, which reduces the diffusion of inter-trace activation and thus
23 limits the detrimental generalization effect for MISMATCH trials.

24 *Alternative interpretation and potential caveats*

25
26 An alternative interpretation would be that the ESI does not facilitate sensorimotor
27 simulation of trace-specific features, but instead bias the retrieval orientation (Madore et al.,
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 2019; see also Herron & Rugg, 2003; Morcom & Rugg, 2012). The ESI may focus the
4 participants' retrieval attempts on the specific details highlighted during the ESI (e.g., the
5 clothes of the people imagined). This orientation would be actively maintained (if sufficient
6 cognitive resources are available) until the subsequent memory task (see Herron, 2018). This
7 focus induced by the ESI would benefit to the subsequent task in the condition where the
8 distinctive details are limited (i.e., in the LOW DISTINCTIVENESS condition) and crucial
9 (i.e., for the MISMATCH trials), but not in the condition where the distinctive details are more
10 numerous (i.e., in the HIGH DISTINCTIVENESS condition). The present study data cannot
11 support an Act-In interpretation over a retrieval orientation interpretation. It would therefore be
12 interesting for future studies to provide more evidence regarding the precise mechanisms
13 underlying the ESI.
14
15
16
17
18
19
20
21
22
23
24
25
26
27

28 The benefits of the ESI on the reduction of memory errors may seem contradictory with
29 the results reported by Thakral et al. (2019) using the DRM paradigm, as they observed that the
30 ESI increased the recall of critical lures. However, the DRM paradigm is very different from
31 the paradigm used in the present study in several aspects. Indeed, whereas our paradigm
32 proposes to recognize the correct associations between previously unknown characters and
33 specific actions, the DRM consists in recalling well-known target words semantically related
34 to a critical lure. According to the Act-In model, this semantic relationship is formed by the
35 accumulation of experiences where target words and critical lures co-occurred. This
36 accumulation strengthens the binding between them and increases the likelihood that the
37 presentation of the target words triggers both the simulation of their own features, and those of
38 the critical lure, during the DRM study phase, through an extended diffusion of inter-trace
39 activation (see also the activation-monitoring hypothesis, Roediger & McDermott, 2000;
40 Roediger, Watson, McDermott, & Gallo, 2001). In turn, the study phase will leave memory
41 traces that reflect these simulations. Subsequently in the recall phase, when the target words are
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 recalled, the critical lure will most likely be erroneously recalled because the memory trace of
4 the study phase includes the simulation of its features, albeit unperceived. This likelihood would
5 increase with the amount of perceptual detail of the lure simulated during the study phase (see
6 also Johnson and Raye's (1981) reality monitoring model) but also during the recall. Thus, if
7 the ESI induces a facilitation of sensorimotor simulation of event-specific features, it can
8 therefore facilitate the simulation, not only of the features of the memory trace of the DRM
9 study phase that correspond to the features of the target words that were actually perceived, but
10 of all the features of the trace, including those that correspond to the features of the critical
11 lures. This can in turn results in more erroneous recall of critical lures after the ESI. As in our
12 paradigm the characters are new, there is no such extended diffusion of inter-trace activation
13 during the study phase, and it is logical to find a reduction in false alarms after the ESI rather
14 than an increase
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

30 This explanation is consistent with the Source Monitoring Framework (SMF) which
31 also assumes that cues (e.g., the studied words of the DRM list) evoke memory information
32 from multiple episodes combined with more general knowledge, and that this evocation itself
33 leaves traces (see Lindsay, 2008). A faulty monitoring during the study phase produces source
34 confusions at the recall phase, and participants mistakenly remember the critical item as having
35 been presented, instead of merely cognitively activated (or simulated), at study (Nichols &
36 Loftus, 2019). Regarding the effect of the ESI in the DRM, one might suppose that the ESI
37 increases the confidence that the critical lure has also been studied, and this confidence-boosting
38 effect results in a sort of imagination inflation (Garry & Polaschek, 2000).
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53

54 One potential caveat is that it remains to be determined whether similar results would
55 be observed using another form of specificity induction, and/or another form of control
56 induction. Although our study was not aimed at determining the essential components of the
57
58
59
60

1
2
3 ESI to observe beneficial effects on a subsequent given task, it is important that future studies
4 address this issue. As mentioned, comparable behavioral effects have been reported whether an
5 imagination specificity induction or a memory specificity induction is compared to a math
6 control induction (see Madore et al., 2019). We argue that simulation of trace-specific
7 sensorimotor features is at least one of the essential components to observe beneficial induction
8 effect on the retrieval of specific perceptual information (for a related topic, see Sheldon et al.,
9 2019). But is the construction of a mental scene (setting, characters, actions) also an essential
10 component? Does the subsequent task have to include the same components as the ESI? These
11 issues may warrant further investigation. In addition, comparable behavioral effects have also
12 been frequently reported whether a math control induction or a general impressions control
13 induction (asking questions about participant's general impressions of the content of a video
14 they viewed) is compared to the classic ESI on several tasks (e.g., Madore et al., 2014).
15 However, the math control induction is known to provide a more neutral baseline. There is
16 therefore no reason to believe that using the impression control induction instead of the math
17 control induction would have yielded different relevant results in our study, as both inductions
18 do not involve simulating trace-specific sensorimotor features. But the choice of control
19 induction will be much more important for any study that aims to determine the essential
20 components of the ESI, a work that we strongly encourage.

21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47 Finally, it is worth noting as a limitation of the current data that the present study only
48 reports one experiment with a single demonstration of the critical effects. These effects should
49 be taken with caution before future studies replicate them. These studies could also test some
50 hypotheses more thoroughly, such as whether or not the ESI targets sensorimotor simulation.
51 For instance, one could address this hypothesis by observing whether the benefits of the ESI on
52 memory errors in the low distinctiveness condition are suppressed if a dynamic visual noise
53
54
55
56
57
58
59
60

(DVN) is displayed during the test phase (see Purkart et al., 2019). The DVN should also have a detrimental or beneficial effect depending on the distinctiveness condition and the trial type in the control induction condition if access to distinctive trace-specific features is reduced by the DVN. We also strongly encourage such a study.

CONCLUSION

There is growing empirical support for the dynamic and constructive conception of memory (see Schacter & Addis, 2007a, 2007b; Surprenant & Neath, 2009; Versace et al., 2009, 2014). This vision of an emergent and dynamic memory that reconstructs our past experiences makes it possible to consider ways of improving not only the memorization of an event but, above all, the reconstruction of that event. The constructive nature of memory requires a focus on the fidelity and accuracy of reconstruction (see Koriat et al., 2000). This focus is all the more necessary in ecological situations such as eyewitness testimony. Can witnesses be considered to have a good memory of an aggressor if they can remember some features of the aggressor but not those that distinguish him from an innocent person who looks like him? An effective memory is one that produces few errors. As such, interventions should aim to facilitate accurate reconstruction and reduce memory errors in order to improve memory efficiency. To our knowledge, the present study is the first to show a beneficial effect of the ESI on memory errors in a recognition task. However, caution must be exercised and other studies showing similar results are needed. We suggest that the beneficial effect of the ESI in a recognition task could be observed by taking trace distinctiveness into account, in particular when the traces do not already benefit from high distinctiveness. Although the ESI appears to be an intervention that can improve memory efficiency, the mechanisms underlying it still have to be precisely determined. The data from the present study suggest that the ESI targets the sensorimotor simulation mechanism by facilitating the simulation/activation of trace-specific features (intra-

1
2
3 trace diffusion). The activation of these specific features would increase trace distinctiveness
4 and reduce the observed generalization effect (i.e., reduce inter-trace activation diffusion).
5
6 Further studies are needed to confirm this interpretation. For instance, by using a DVN in
7
8 addition to the ESI (as Purkart et al., 2019) while manipulating trace distinctiveness. Similar
9
10 findings in future studies would suggest that it is possible to reduce memory errors through
11
12 interventions such as the ESI. This would make it possible to consider psycho-legal and clinical
13
14 applications in populations where memory accuracy is impacted, such as the elderly (Greene &
15
16 Naveh-Benjamin, 2020; Korkki et al., 2020).
17
18
19
20
21
22
23

24 **ETHICS STATEMENT**

25
26 This study was carried out in accordance with the recommendations of the French Law (Loi
27
28 Jardé n°2012-300) with written informed consent being obtained from all the subjects in
29
30 accordance with the Declaration of Helsinki. An ethics approval was issued for the current study
31
32 by the ethics committee of Clermont Auvergne University (IRB00011540-2019-43).
33
34
35
36
37

38 **AUTHOR CONTRIBUTIONS**

39
40 RP and JM participated in all the aspects of the study (design of the experiments, conduct of
41
42 the experiments, analysis and interpretation of the data, and redaction of the manuscript). RV
43
44 and GV participated in the design of the experiments, interpretation of the data, and redaction
45
46 of the manuscript.
47
48
49
50

51 **DECLARATION OF CONFLICTING INTERESTS**

52
53 The Author(s) declare(s) that there is no conflict of interest.
54
55
56
57

58 **FUNDING**

1
2
3 This research received no specific grant from any funding agency in the public, commercial,
4 or not-for-profit sectors.
5
6
7
8
9

10 **ACKNOWLEDGMENT**

11
12 Jordan Mille and Guillaume T. Vallet are supported by a grant from the Auvergne-Rhône-Alpes
13 region for the project Vieillissement, Maladie Chronique et Stimulation Cognitive (ViMaCC).
14
15 The ViMaCC project is co-financed by the European Union within the framework of the Fonds
16 européen de développement régional (FEDER).
17
18
19
20
21
22
23

24 **REFERENCES**

- 25
26 Barsalou, L. W. (2008). Grounded Cognition. *Annual Review of Psychology*, *59*(1), 617–645.
27
28 <https://doi.org/10.1146/annurev.psych.59.103006.093639>
29
30 Barsalou, L. W. (2009). Simulation, situated conceptualization, and prediction. *Philosophical*
31 *Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1281–1289.
32
33 <https://doi.org/10.1098/rstb.2008.0319>
34
35
36
37 Bartlett, F. C. (1932). *Remembering*. Cambridge. Cambridge University Press England.
38
39 Brown, G. D. A., Neath, I., & Chater, N. (2007). A temporal ratio model of memory.
40
41 *Psychological Review*, *114*(3), 539–576. <https://doi.org/10.1037/0033-295X.114.3.539>
42
43
44 Brunel, L. (2013). Does bigger mean louder? Crossmodal congruency and memory judgment.
45
46 *Multisensory Research*, *26*(0), 67–68. <https://doi.org/10.1163/22134808-000S0045>
47
48
49 Brunel, L., Goldstone, R. L., Vallet, G., Riou, B., & Versace, R. (2013). When Seeing a Dog
50
51 Activates the Bark. *Experimental Psychology*, *60*(2), 100–112.
52
53 <https://doi.org/10.1027/1618-3169/a000176>
54
55
56 Brunel, L., Lesourd, M., Labeye, E., & Versace, R. (2010). The sensory nature of knowledge:
57
58 Sensory priming effects in semantic categorization. *The Quarterly Journal of*
59
60

1
2
3 *Experimental Psychology*, 63(5), 955–964.

4
5 <https://doi.org/10.1080/17470210903134369>

6
7
8 Calvillo, D. P., & Parong, J. A. (2016). The misinformation effect is unrelated to the DRM

9
10 effect with and without a DRM warning. *Memory*, 24(3), 324–333.

11
12 <https://doi.org/10.1080/09658211.2015.1005633>

13
14 Clancy, S. A., Schacter, D. L., McNally, R. J., & Pitman, R. K. (2000). False Recognition in

15
16 Women Reporting Recovered Memories of Sexual Abuse. *Psychological Science*,

17
18 11(1), 26–31. <https://doi.org/10.1111/1467-9280.00210>

19
20
21 Dabic, S., Rey, A. E., Navarro, J., & Versace, R. (2018). Haptic modality takes its time:

22
23 Dynamic of activations of sensory modalities in perceptual and memory processes.

24
25 *International Journal of Psychology*, 53(3), 237–242.

26
27 <https://doi.org/10.1002/ijop.12368>

28
29
30 Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate

31
32 recall. *Journal of Experimental Psychology*, 58(1), 17–22.

33
34 <https://doi.org/10.1037/h0046671>

35
36
37 Ekstrom, A. D., & Yonelinas, A. P. (2020). Precision, binding, and the hippocampus:

38
39 Precisely what are we talking about? *Neuropsychologia*, 138, 107341.

40
41 <https://doi.org/10.1016/j.neuropsychologia.2020.107341>

42
43
44 Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical

45
46 power analysis program for the social, behavioral, and biomedical sciences. *Behavior*

47
48 *Research Methods*, 39(2), 175–191. <https://doi.org/10.3758/BF03193146>

49
50
51 Fisher, R. P., & Geiselman, R. E. (1992). *Memory enhancing techniques for investigative*

52
53 *interviewing: The cognitive interview*. Charles C Thomas Publisher.

- 1
2
3 Gaesser, B., Sacchetti, D. C., Addis, D. R., & Schacter, D. L. (2011). Characterizing age-
4 related changes in remembering the past and imagining the future. *Psychology and*
5 *Aging, 26*(1), 80–84. <https://doi.org/10.1037/a0021054>
6
7
8
9
10 Garry, M., & Polaschek, D. L. L. (2000). Imagination and Memory. *Current Directions in*
11 *Psychological Science, 9*(1), 6–10. <https://doi.org/10.1111/1467-8721.00048>
12
13
14 Greene, N. R., & Naveh-Benjamin, M. (2020). A Specificity Principle of Memory: Evidence
15 From Aging and Associative Memory. *Psychological Science, 31*(3), 316–331.
16
17 <https://doi.org/10.1177/0956797620901760>
18
19
20
21 Herron, J. E. (2018). Direct electrophysiological evidence for the maintenance of retrieval
22 orientations and the role of cognitive control. *NeuroImage, 172*, 228.
23
24
25
26 Herron, J. E., & Rugg, M. D. (2003). Retrieval Orientation and the Control of Recollection.
27 *Journal of Cognitive Neuroscience, 15*(6), 843–854.
28
29 <https://doi.org/10.1162/089892903322370762>
30
31
32
33 Howe, M. L. (1998). When Distinctiveness Fails, False Memories Prevail. *Journal of*
34 *Experimental Child Psychology, 71*(2), 170–177.
35
36 <https://doi.org/10.1006/jecp.1998.2469>
37
38
39
40 Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*(1), 67–
41 85. <https://doi.org/10.1037/0033-295X.88.1.67>
42
43
44 Koriat, A., Goldsmith, M., & Pansky, A. (2000). Toward a psychology of memory accuracy.
45 *Annual Review of Psychology, 51*, 481–537.
46
47 <https://doi.org/10.1146/annurev.psych.51.1.481>
48
49
50
51 Korkki, S. M., Richter, F. R., Jeyarathnarajah, P., & Simons, J. S. (2020). Healthy ageing
52 reduces the precision of episodic memory retrieval. *Psychology and Aging, 35*(1),
53 124–142. <https://doi.org/10.1037/pag0000432>
54
55
56
57
58
59
60

- 1
2
3 Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and
4 autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology*
5 *and Aging, 17*(4), 677–689. <https://doi.org/10.1037/0882-7974.17.4.677>
6
7
8
9
10 Lindsay, D. S. (2008). 2.19—Source Monitoring. In J. H. Byrne (Ed.), *Learning and Memory:*
11 *A Comprehensive Reference* (pp. 325–347). Academic Press.
12
13 <https://doi.org/10.1016/B978-012370509-9.00175-3>
14
15
16
17 Loftus, E. F., & Palmer, J. C. (1996). Eyewitness Testimony. In P. Banyard & A. Grayson
18 (Eds.), *Introducing Psychological Research: Sixty Studies that Shape Psychology* (pp.
19 305–309). Macmillan Education UK. https://doi.org/10.1007/978-1-349-24483-6_46
20
21
22
23
24 Loftus, Elizabeth F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An
25 example of the interaction between language and memory. *Journal of Verbal Learning*
26 *and Verbal Behavior, 13*(5), 585–589. [https://doi.org/10.1016/S0022-5371\(74\)80011-](https://doi.org/10.1016/S0022-5371(74)80011-3)
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- Lyle, K., & Johnson, M. (2006). Importing perceived features into false memories. *Memory, 14*(2), 197–213. <https://doi.org/10.1080/09658210544000060>
- Madore, K. P., Gaesser, B., & Schacter, D. L. (2014). Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*(3), 609–622. <https://doi.org/10.1037/a0034885>
- Madore, K. P., & Schacter, D. L. (2015). Remembering the past and imagining the future: Selective effects of an episodic specificity induction on detail generation. *The Quarterly Journal of Experimental Psychology, 69*(2), 285–298. <https://doi.org/10.1080/17470218.2014.999097>
- Madore, K. P., Jing, H. G., & Schacter, D. L. (2019). Selective effects of specificity inductions on episodic details: Evidence for an event construction account. *Memory,*

- 1
2
3 0(0), 1–11. <https://doi.org/10.1080/09658211.2018.1502322>
4
5 McConnell, J., & Quinn, J. G. (2004). Complexity factors in visuo-spatial working memory.
6
7 *Memory*, 12(3), 338–350. <https://doi.org/10.1080/09658210344000035>
8
9
10 Morcom, A. M., & Rugg, M. D. (2012). Retrieval Orientation and the Control of Recollection
11
12 : An fMRI Study. *Journal of Cognitive Neuroscience*, 24(12), 2372–2384.
13
14 https://doi.org/10.1162/jocn_a_00299
15
16
17 Memon, A., Meissner, C. A., & Fraser, J. (2010). The Cognitive Interview: A meta-analytic
18
19 review and study space analysis of the past 25 years. *Psychology, Public Policy, and*
20
21 *Law*, 16(4), 340–372. <https://doi.org/10.1037/a0020518>
22
23
24 Meyersburg, C. A., Bogdan, R., Gallo, D. A., & McNally, R. J. (2009). False memory
25
26 propensity in people reporting recovered memories of past lives. *Journal of Abnormal*
27
28 *Psychology*, 118(2), 399–404. <https://doi.org/10.1037/a0015371>
29
30
31 Mullally, S. L., & Maguire, E. A. (2014). Memory, Imagination, and Predicting the Future: A
32
33 Common Brain Mechanism? *The Neuroscientist*, 20(3), 220–234.
34
35 <https://doi.org/10.1177/1073858413495091>
36
37
38 Nichols, R. M., & Loftus, E. F. (2019). Who is susceptible in three false memory tasks?
39
40 *Memory*, 27(7), 962–984. <https://doi.org/10.1080/09658211.2019.1611862>
41
42
43 Ost, J., Blank, H., Davies, J., Jones, G., Lambert, K., & Salmon, K. (2013). False Memory ≠
44
45 False Memory: DRM Errors Are Unrelated to the Misinformation Effect. *PLOS ONE*,
46
47 8(4), e57939. <https://doi.org/10.1371/journal.pone.0057939>
48
49
50 Ozubko, J. D., & Joordens, S. (2008). Super Memory Bros.: Going from mirror patterns to
51
52 concordant patterns via similarity enhancements. *Memory & Cognition*, 36(8), 1391–
53
54 1402. <https://doi.org/10.3758/MC.36.8.1391>
55
56
57 Patihis, L. (2016). Individual differences and correlates of highly superior autobiographical
58
59 memory. *Memory*, 24(7), 961–978. <https://doi.org/10.1080/09658211.2015.1061011>
60

- 1
2
3 Purkart, R., Versace, R., & Vallet, G. T. (2019). "Does it improve the mind's eye?":
4
5 Sensorimotor simulation in episodic event construction. *Frontiers in Psychology, 10*,
6
7 1403.
8
9
- 10 Rey, A. E., Riou, B., Muller, D., Dabic, S., & Versace, R. (2015). "The mask who wasn't
11
12 there": Visual masking effect with the perceptual absence of the mask. *Journal of*
13
14 *Experimental Psychology: Learning, Memory, and Cognition, 41*(2), 567.
15
16
- 17 Riou, B., Rey, A. E., Vallet, G. T., Cuny, C., & Versace, R. (2015). Perceptual processing
18
19 affects the reactivation of a sensory dimension during a categorization task. *Quarterly*
20
21 *Journal of Experimental Psychology, 68*(6), 1223–1230.
22
23 <https://doi.org/10.1080/17470218.2014.978876>
24
25
- 26 Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words
27
28 not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and*
29
30 *Cognition, 21*(4), 803.
31
32
- 33 Roediger, H. L., & McDermott, K. B. (2000a). Distortions of memory. In *The Oxford*
34
35 *handbook of memory* (pp. 149–162). Oxford University Press.
36
37
- 38 Roediger, H. L., & McDermott, K. B. (2000b). Tricks of Memory. *Current Directions in*
39
40 *Psychological Science, 9*(4), 123–127. <https://doi.org/10.1111/1467-8721.00075>
41
42
- 43 Roediger, H. L., Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that
44
45 determine false recall: A multiple regression analysis. *Psychonomic Bulletin &*
46
47 *Review, 8*(3), 385–407. <https://doi.org/10.3758/BF03196177>
48
49
- 50 Romero, K., & Moscovitch, M. (2012). Episodic memory and event construction in aging and
51
52 amnesia. *Journal of Memory and Language, 67*(2), 270–284.
53
54
- 55 Schacter, D. L., & Addis, D. R. (2007a). Constructive memory: The ghosts of past and future.
56
57 *Nature, 445*(7123), 27–27. <https://doi.org/10.1038/445027a>
58
59
- 60 Schacter, D. L., & Addis, D. R. (2007b). The cognitive neuroscience of constructive memory:

1
2
3 Remembering the past and imagining the future. *Philosophical Transactions of the*
4 *Royal Society of London B: Biological Sciences*, 362(1481), 773–786.

5
6
7 <https://doi.org/10.1098/rstb.2007.2087>

8
9
10 Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K.
11
12 (2012). The Future of Memory: Remembering, Imagining, and the Brain. *Neuron*,
13
14 76(4), 677–694. <https://doi.org/10.1016/j.neuron.2012.11.001>

15
16
17 Schacter, D. L., & Coyle, J. T. (1995). *Memory Distortion: How Minds, Brains, and Societies*
18
19 *Reconstruct the Past*. Harvard University Press.

20
21 Schacter, D. L., Guerin, S. A., & St. Jacques, P. L. (2011). Memory distortion: An adaptive
22
23 perspective. *Trends in Cognitive Sciences*, 15(10), 467–474.
24
25 <https://doi.org/10.1016/j.tics.2011.08.004>

26
27
28 Sheldon, S., Gurguryan, L., Madore, K. P., & Schacter, D. L. (2019). Constructing
29
30 autobiographical events within a spatial or temporal context: A comparison of two
31
32 targeted episodic induction techniques. *Memory*, 27(7), 881–893.
33
34
35 <https://doi.org/10.1080/09658211.2019.1586952>

36
37
38 Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory:
39
40 Applications to dementia and amnesia. *Journal of Experimental Psychology: General*,
41
42 117(1), 34–50.

43
44
45 Surprenant, A. M., & Neath, I. (2009). *Principles of Memory*. Psychology Press.

46
47 Thakral, P. P., Madore, K. P., Devitt, A. L., & Schacter, D. L. (2019). Adaptive constructive
48
49 processes : An episodic specificity induction impacts false recall in the Deese-
50
51 Roediger- McDermott paradigm. *Journal of Experimental Psychology : General*,
52
53 148(9), 1480–1493. <https://doi.org/10.1037/xge0000577>

54
55
56 Vallet, G., Brunel, L., & Versace, R. (2010). The Perceptual Nature of the Cross-Modal
57
58 Priming Effect. *Experimental Psychology*, 57(5), 376–382.

1
2
3 <https://doi.org/10.1027/1618-3169/a000045>
4

5 Vallet, G. T., Hudon, C., Simard, M., & Versace, R. (2013). The disconnection syndrome in
6 the Alzheimer's disease: The cross-modal priming example. *Cortex*, *49*(9), 2402–
7 2415. <https://doi.org/10.1016/j.cortex.2012.10.010>
8
9

10 Vallet, G. T., Simard, M., Versace, R., & Mazza, S. (2013). The perceptual nature of
11 audiovisual interactions for semantic knowledge in young and elderly adults. *Acta*
12 *Psychologica*, *143*(3), 253–260. <https://doi.org/10.1016/j.actpsy.2013.04.009>
13
14
15
16

17 Versace, R., Labeye, E., Badard, G., & Rose, M. (2009). The contents of long-term memory
18 and the emergence of knowledge. *European Journal of Cognitive Psychology*, *21*(4),
19 522–560.
20
21
22
23
24

25 Versace, R., Vallet, G. T., Riou, B., Lesourd, M., Labeye, É., & Brunel, L. (2014). Act-In: An
26 integrated view of memory mechanisms. *Journal of Cognitive Psychology*, *26*(3),
27 280–306.
28
29
30
31

32 Yee, E., Chrysikou, E. G., Hoffman, E., & Thompson-Schill, S. L. (2013). Manual Experience
33 Shapes Object Representations. *Psychological Science*, *24*(6), 909–919.
34
35
36
37
38 <https://doi.org/10.1177/0956797612464658>
39
40
41
42
43

44 APPENDIX

45
46 **Table 2.** List of actions and objects used in the memory task (translated from French).
47

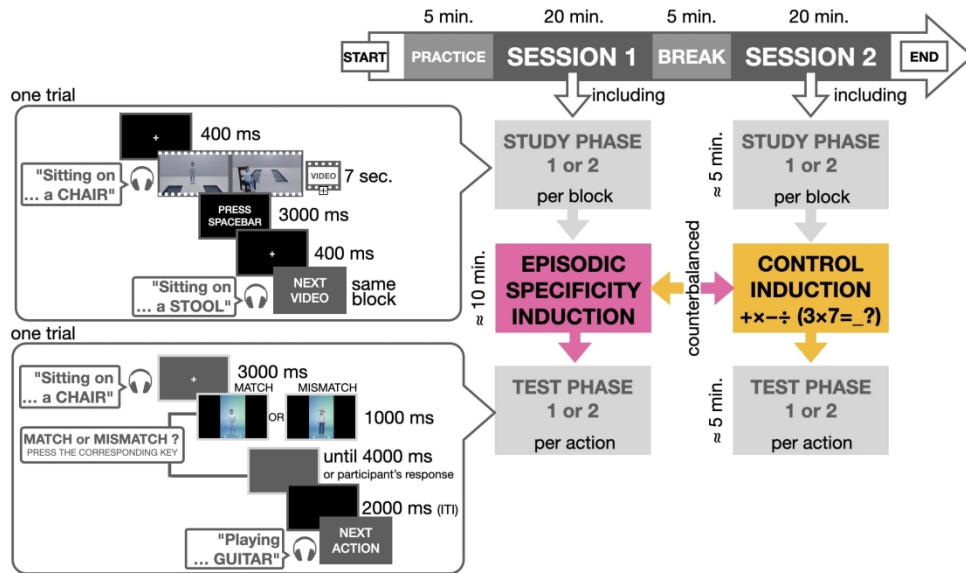
48
49 **[Insert Table 2.]**
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



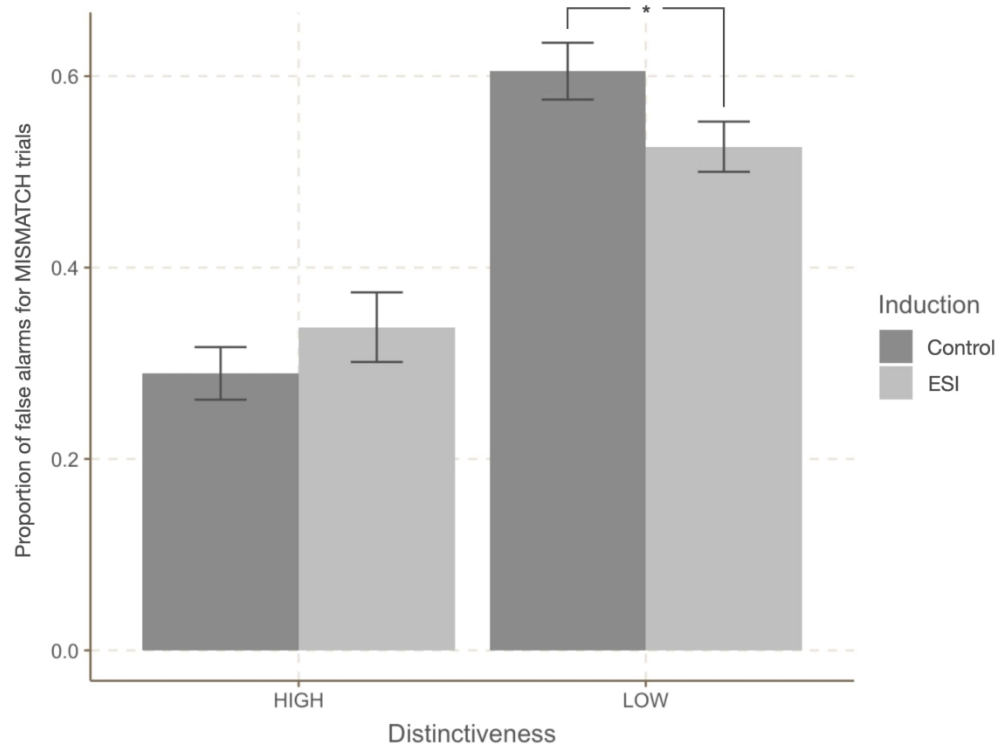
Photographs of the characters in a block in each distinctiveness condition.

1159x287mm (72 x 72 DPI)



Schematic procedure of the experiment.

885x522mm (72 x 72 DPI)



Comparison of the mean rates of false alarms for the different Induction types (Control vs. ESI) in each Distinctiveness condition (HIGH vs. LOW) for MISMATCH trials (incorrectly endorsing the test character as the one who performed the action on the object enounced). Gray bars represent standard errors corrected for the within-participant design.

927x721mm (72 x 72 DPI)

TRIALS	DISTINCTIVENESS	INDUCTION	HITS		FA
			<i>M</i>	(SD)	<i>M</i>
MISMATCH	HIGH	CONTROL	-	-	0.29
		ESI	-	-	0.34
	LOW	CONTROL	-	-	<u>0.61</u>
		ESI	-	-	<u>0.53</u>
MATCH	HIGH	CONTROL	0.59	(0.23)	-
		ESI	0.56	(0.23)	-
	LOW	CONTROL	0.68	(0.20)	-
		ESI	0.68	(0.21)	-

For Peer Review Only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

RT (on correct responses)		
(SD)	<i>M</i>	(SD)
(0.17)	935	(240)
(0.22)	1032	(291)
(0.18)	1091	(342)
(0.16)	1136	(450)
-	944	(353)
-	958	(294)
-	1007	(326)
-	1074	(349)

For Peer Review Only

LIST A	LIST B
Sit on: a chair an armchair a park bench a stool	Play: the violin the piano the guitar the drums
Water: a flowerpot a tree a bush a cactus	Put: a robot toy a dinosaur toy a horse toy a cat toy
Utilize: a computer a television a hi-fi system a jukebox	Cooking with: a barbecue a gas cooker a coffee machine a microwave
Boarding: a car a bus a motorbike an aeroplane	Use: a shower a bathtub a sink a toilet
Lie down on: a bed a sofa a deckchair a bench	Contemplate: a statue an armour a painting a fountain
Pick up: a superhero toy a dragon toy a helicopter toy a butterfly toy	Do sports with: a treadmill a punching bag a weight bench a basketball