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Can Exposure to Fascinating Stimuli Affect Memory Performance in Mentally Fatigued People? A study on Encoding and Retrieval

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Abstract

Exposure to restorative environments can restore attention from mental fatigue. The question arises as to whether this restoration is peculiar to attention or whether it also pertains to memory performance. This study aims to verify whether memory performance can be restored in mentally fatigued people. A week after the baseline assessment, 62 subjects were assigned to an encoding or a retrieval condition. Each condition was made up of two memory assessments on a word free recall and a face recognition task: the first assessment was done after the induction of mental fatigue and the second after exposure to fascinating stimuli. There was no evidence of a restorative effect on the verbal free recall in the encoding or in the retrieval condition. For the recognition task, the significant effect in the retrieval condition implies that exposure to fascinating stimuli affects memory performance, relieving the process of mental fatigue.

Introduction

It is known that the restorative characteristics of an environment have a positive effect on attention, enhancing attentional performance [1-5] but can they also affect memory? This paper focuses on environmental factors that could enhance or impair memory performance, specifically the effect of fascination [6] on encoding and retrieval processes.

Attention is a part of the memory process, being decisive for the stimulus encoding (the process of acquiring information and placing it into memory) and retrieval from memory (the process of recovering previously encoded information). It has been argued that a way to restore directed attention (voluntary effortful attention; James [7]) is through exposure to natural environments that can help to return information processing to an effectively functioning state [3,6]. Natural environments are assumed to attract involuntary attention [7], the kind of attention that does not demand mental effort and is attracted to stimuli having innately fascinating qualities. In the [6] Attention Restoration Theory (ART), this type of involuntary and effortless attention, which can derive from many sources (process or content; for more details see ref. [6]), was named fascination. Fascination is one of the characteristics of a restorative environment, which provides the opportunity to recover depleted directed attentional capacity [8]; even very short exposure can promote restorative benefits [3], which can occur without conscious intention [9]. Basically, memory capability should be restored in a similar way to attentional capacity: memory may also improve by exposure to restorative environments. Restorative environments are less cognitively fatiguing than non-restorative environments [3], leaving "more space" for further and deeper elaboration of the ongoing task material; the depth of elaboration affects the coding of a stimulus and the possibility in recalling it [10].

As a general rule, what attracts attention is automatically brought to memory [11]; therefore, the issue of recall can be described in terms of attention. According to Kahneman [12] capacity model, attention is identified with effort and effort is a special case of arousal. Paying attention to interesting (fascinating) stimuli does not require effort [13-15] and arousal levels increase when viewing interesting stimuli that attract involuntary attention [16].

One of the most consistent findings in psychology is that optimal arousal is necessary to produce efficient performance for any given task [17]. The influence of subject arousal on immediate and delayed recall of pictures was found by Bradley et al. [18] who also recorded an effect on reaction times in a speeded recognition test, in which high-arousal stimuli produced a faster reaction time than their low-arousal counterparts. The most classic explanation is that the pleasantness of material enhances subject activation, which, in turn, enhances memory [19].

As already mentioned, attention plays an important role in the memory process. For example, the Backward Digit Span task is a memory test that relies heavily on the directed attention mechanism because the task requires items (digits) to be moved in and out of the focus of attention. Berman et al. [4] compared the restorative value of interactions with nature vs. urban environments to improve cognitive functioning; they controlled activities that subjects performed while interacting with nature, and they showed that walking in nature and viewing pictures of nature improved Backward Digit Span task performance.

A rather consistent result in the literature is an improvement in recall when the subject is in a positive mood, which can be due either to the stimulus material or to some specific technique of inducing emotions [20].

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Concerning the effects of the environment on recall, natural settings tend to increase positive emotions and decrease negative emotions when compared with urban settings [8,21,22] though Hartig et al. [23] showed that differences in mood induced by different environments had only small differential effects on episodic memory.

Berto et al, [5] tested the role of fascination (high vs. low) on incidental recall of photographs of natural and urban environments. In general, natural scenes were better recalled than urban scenes and scenes high in fascination (which engage involuntary effortless attention) were recalled better than scenes low in fascination, independently of the environmental category; among scenes low in fascination, those depicting natural environments were recalled better than those of urban scenes.

However, all these manipulations concerned the to-be-remembered material or the task characteristics, but what about events that occur immediately before or after the encoding and the retrieval process? Considering that attention plays an important role in the memory process, both encoding and retrieval, and knowing that attention can be restored by exposure to fascinating stimuli, it is important to verify whether memory performance can also be improved in a similar way. The nature of encoding and retrieval processes has been extensively explored, and the aim of this paper is not to address this topic directly.

The following experiment has been planned to assess two aims: first, whether attentional fatigue (induced by performing a sustained attention task, the SART) affected memory encoding and/or retrieval and, second, whether the encoding and retrieval process could be affected by exposure to fascinating stimulus material.

To achieve this aim, the procedure was made up of two experimental conditions, called encoding and retrieval, respectively, each made up of two blocks. The first block tested the effect that attentional fatigue can have on the encoding and/or retrieval of verbal and visual material, which were assessed with a free recall of words task and a face recognition task. The second block tested the effect of exposure to fascinating stimuli on these processes and tasks. The study's aim was to compare subjects' performance within each condition and not between conditions; the interest was not in comparing processes (encoding vs. retrieval) but in assessing performance (fatigue vs. fascination) with respect to verbal and visual material within each process.

The SART is a sustained attention task that creates a state of mental fatigue [3], which should make the encoding and retrieval processes more difficult. On the contrary, exposure to the fascinating scenes should allow recovery from the previously induced fatigue and relieve the encoding and retrieval processes. In this study, it was hypothesized that, after exposure to fascinating stimuli, the participants would perform better on the memory tasks (free recall and visual recognition) compared to performing the memory task after the induction of the attentional fatigue state. Performance after the induction of attentional fatigue was expected to worsen when compared to the baseline assessment, whereas performance would return or even outdo the baseline after exposure to fascinating stimuli, independently of the memory task condition.

Method

Participants

Sixty-two younger adults (10 male and 52 female, M=19.88 years, SD=4.02) recruited from the general psychology class, volunteered to participate and receive credit to fulfill a research participation requirement for students enrolled in psychology courses.

Material

Twenty color photographs depicting natural and urban environments were used. These photographs were selected for their fascination score from a sample of 100 pictures. In a previous work [5] they were assessed with respect to the Perceived Restorativeness Scale (PRS; [24]) by a group of 40 students (M age=26, SD=5.23). The PRS is made up of 26 items measuring the perception of five restorative factors: fascination, being-away, coherence, scope, compatibility (for more details see ref. [25,26].

Each item is assessed on an 11-point scale (0=not at all, 6=rather, 10=completely). The students were requested to answer all PRS items, though only those associated with fascination were of interest to the study aim. Accordingly, 20 photographs were chosen to depict both natural and urban scenes[1] high in fascination (mean fascination score=8.11, SD=0.57) (Figure 1).

Figure 1: Examples of stimulus material high in fascination.

Instruments

To induce mental fatigue

The Sustained Attention to Response Task (SART) [27,28] was used to create the mental fatigue state. The SART is a computer-administered go/no-go test. It consisted of 240 digits from 1 to 9 (24 different digit combinations); 10% are targets (24 targets), while the remaining 216 are non-targets. The digit 3 is designated as the target. The digits are presented on the computer screen for 250 ms every 1125 ms. The participants were instructed to press the space bar on the keyboard when they saw a non-target digit and avoid pressing the space bar when the target appeared. The test takes five minutes, and it is very demanding [3].

To assess memory performance

Because verbal and visual stimuli are processed in different ways [29,30], memory was tested by having participants perform a word free recall and a visual recognition task to assess verbal and visual memory,

1 The engagement of involuntary attention occurs more often in attending to natural scenes because they are intrinsically high in fascination; however certain urban environments can also be "comfortable" from a cognitive point of view (see Ref. [5]).

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respectively. In order to avoid learning effects, different but comparable versions of the tests were used.

In the free recall task, the participants were requested to study a list of 40 words. Three different study lists were prepared, one in the baseline assessment and the other two in the experimental conditions (encoding and retrieval). The lists consisted of words comparable in frequency and imagery value [31,32], and their meaning was not related to the stimulus material content. The words were presented in a randomized order on the computer screen at a two-second rate. The participants had to write down as many words as they could in four minutes. No word order constraints were set.

An ad hoc recognition task was developed to assess participants' visual memory. The recognition task used was similar to the "memory for faces" sub-test of the Test of Memory and Learning (TOMAL; [33]). Ninety faces were selected among the 125 faces making up the sub-test to create three sets of 30 faces each (comparable for gender, age, ethnicity, and physical features) to be used in the baseline and in the two experimental conditions. For each set, 12 faces were studied and presented on the computer screen at a two-second rate. The participants' task was to recognize the 12 faces among a set of 30 faces, with 18 distracters simultaneously presented. The participants were given a sheet with the 30 faces printed in random order, and the subjects marked their responses with a red pen.

Procedure

The experiment comprised of a baseline assessment aimed to assess the participants' "at rest" verbal and visual memory capacity and two different experimental conditions, encoding and retrieval. The encoding and retrieval conditions included two verbal and visual memory assessments each. Of the 62 participants undergoing the baseline assessment, half were randomly assigned to the encoding condition and half to the retrieval condition.

Baseline

One week before the experiment, the participants were individually brought into the laboratory for the baseline assessment. After collecting the personal data, the participants sat in front of the computer and started the presentation of the word list. Then the participants had to engage in a distracter task (counting backward by seven from 1250 to 0) for four minutes.

Afterwards, the participants' verbal memory was tested: they had to write down as many words as they could remember from the list in four minutes (free recall task). At this point, the second memory test was administered: the participants had to study serially presented faces. After the face presentation and four minutes of the distracter task (counting backward by seven from 1000 to 0), the participants' visual memory was tested. In two minutes, they had to recognize as many faces as they could on a sheet where eighteen distracting faces were also present (recognition task) (Figure 2).

From the baseline assessment, verbal and visual memory scores were obtained for each participant. The free recall and the recognition tasks were counterbalanced among the subjects.

Encoding condition

To determine whether the induction of attentional fatigue and/or exposure to high-fascination stimuli can affect the encoding process of new material (visual and verbal), the procedure comprised two blocks. The first block assessed the effect of attentional fatigue, and the second block assessed the effect of fascinating stimuli on encoding.

The first block started with participants performing the SART. After the SART, the first list of words was shown to the participants, followed by a four-minute distracter task (counting backward by seven from 177). At this point, the first set of faces was presented, followed by another one-minute distracting task (counting backward by seven from 150). At the end of the first block, the participants performed the first memory assessment: free recall of the words and recognition of the faces.

As in the baseline, there was an interval of about four minutes between the study phase and the memory assessment.

The second block started immediately after the first memory assessment with exposure to the stimulus material: high-fascination scenes. The instructions to the participants before viewing the pictures were as follows: Now a series of photographs of outdoor environments will appear on the computer screen. You should look freely at the photographs; don't try to memorize any detail because this is not a memory task, and no task related to the photographs' content will occur at the end of the presentation. Each photograph appeared in randomized order on the computer screen for 15 seconds (standard exposure time; see [5]) for a total exposure time of five minutes. Then the participants were exposed to the second list of words and set of faces to be studied.

After four minutes of the distracter task, the participants' verbal and visual memories were tested as in the first block (Figure 2).

For each participant, two verbal and two visual memory scores were obtained. The free recall and the recognition task order were counterbalanced within each block.

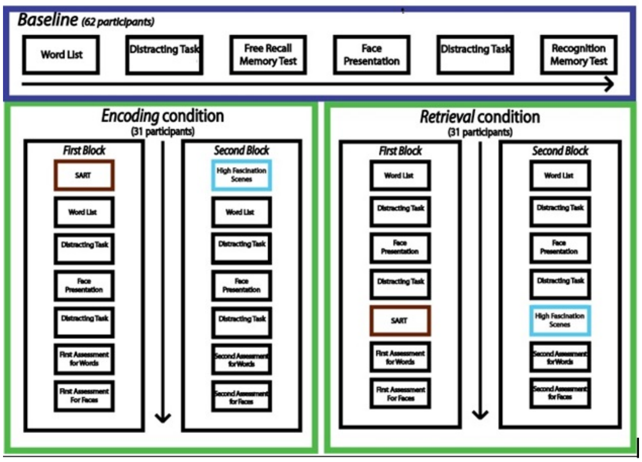

Figure 2: Experimental procedure schema.

Retrieval condition

The tests and the stimulus material were the same as in the encoding condition. The difference was in their sequence. This experimental condition aimed to determine whether attentional fatigue and/or exposure to high-fascination stimuli can affect the retrieval process. As in the encoding condition, the retrieval procedure was made up of two blocks, the first assessing the effect of attentional fatigue and the second assessing the effect of fascinating stimuli on the retrieval process of verbal and visual material (Figure 2).

For each participant, two verbal and two visual memory scores were obtained. The free recall and the recognition task order were counterbalanced within each block.

Data Analysis and Results

Verbal free recall

The analysis of interest for the free recall task was how many words from the study list participants wrote down in the first and second assessments in the two conditions. A word was considered correct when it exactly matched the word on the study list; words never presented were considered intrusions. A three-level repeated-measure ANOVA was performed on the mean number of correct words and intrusions of the baseline, fatigue, and fascination assessments; the condition (encoding vs. retrieval) was the fixed factor. No significant effect and interaction emerged; $p > 0.05$ (Table 1).

Free recall	Condition	Baseline	Fatigue	Fascination
Correct words	Encoding	14.35 (4.45)	14.70 (6.15)	14.32 (5.43)
	Retrieval	13.96 (4.44)	12.61 (5.13)	12.32 (5.24)
Intrusions	Encoding	1.54 (1.67)	1.06 (0.92)	1.16 (1.00)
	Retrieval	1.51 (1.69)	1.83 (2.43)	1.38 (2.43)

Table 1: Mean number of correct responses and intrusions in the baseline, fatigue, and fascination assessments for the free recall task averaged across the two conditions, encoding and retrieval. The standard deviation is in parenthesis.

Visual recognition

For the visual recognition task, the interest was how many previously studied faces the participants recognized in the first and the second assessment in the two conditions. Similarly to words, a face was considered correct when it was one of the previously presented faces; it was an intrusion when a distracting face was marked. A three-level repeated-measure ANOVA was performed on the mean number of correct faces and intrusions in the baseline, fatigue, and fascination assessments. The condition (encoding vs. retrieval) was the fixed factor.

The interaction ASSESSMENT × CONDITION [$F(2.120)=4.73$] and the effect of CORRECT FACES within subjects [$F(2.120)=3.51$] showed significance ($p<0.05$). A significant effect within subjects emerged for INTRUSIONS as well [$F(2.120)=3.81$, $p<0.05$]. To determine where the significant differences were, paired-sample T-tests were performed between the baseline, fatigue, and fascination assessments in both conditions.

The mean number of correct faces differed significantly between baseline and fatigue: $t(30)=4.10$, $p<0.001$, and between fatigue and fascination: $t(30)=-2.15$, $p<0.05$, in the retrieval condition (Table 2). According to the paired-samples T-tests, the mean number of intrusions differed significantly between baseline and fascination in the encoding condition: $t(30)=2.84$, $p<0.001$, (Table 2).

Recognition	Condition	Baseline	Fatigue	Fascination
Correct faces	Encoding	7.67 (2.08)	7.80 (1.75)	8.12 (2.55)
	Retrieval	8.67 (2.17)	7.06 (2.17)	7.87 (2.30)
Intrusions	Encoding	1.32 (1.10)	0.96 (1.11)	0.64 (0.91)
	Retrieval	1.14 (1.17)	1.29 (1.48)	1.22 (1.40)

Table 2: Mean number of correct responses and intrusions in the baseline, fatigue, and fascination assessments for the recognition task averaged across the two conditions, encoding and retrieval. The standard deviation is in parenthesis.

Discussion

Attending to fascinating scenes is less cognitively fatiguing than attending to scenes that require the engagement of directed attention [34]. In mentally fatigued subjects, exposure to fascinating stimuli frees up cognitive resources for further and deeper elaboration of the task material [3]. In this study, it was hypothesized that, after the induction of the attentional fatigue state, memory encoding and retrieval of verbal and visual material should worsen, but memory performance should benefit from exposure to the fascinating scenes returning to or outdoing the baseline memory performance. The results partially support this hypothesis.

For verbal material, there was no change from the baseline performance in free recall during mental fatigue or after exposure to fascinating scenes, and this non-significant result occurred in both conditions. There was no restorative effect for free recall. However, the free recall performance was quite low in both conditions, an average of only 14 of 40 words (approximately 35%). In contrast, the results for visual material show that exposure to fascinating stimuli affected recognition performance during retrieval and reduced the mean number of intrusions during encoding. In the encoding condition, the lack of effects for free recall and visual recognition might be due to the sequence of tasks and photographs (Figure 2). The SART and the encoding task (new visual and verbal material to study) were so close in time that they could have been perceived as one unique task. The subjects' performance on the SART was good, though the task was really fatiguing; perhaps the subjects continued and began encoding the new material without perceiving the break between the tasks. The three tasks kept the subjects focused on the computer screen without producing shifts in the level of attention; perhaps for this reason, there was no decrease in the memory performance after the induction of mental fatigue. On the other hand, if the subjects restored their cognitive effectiveness from the state of mental fatigue through fascinating scene exposure, this restoration may have been lost over time because they had to concentrate to learn the new verbal and visual material (Figure 2). This would also explain the significant decrease in intrusions in the recognition task; the subjects were focused on the tasks, and though the number of correct responses did not increase significantly, the subjects made progressively fewer errors.

As it stands, it seems that the encoding effects for verbal and visual material could not be ruled out because the experimental design may not allow for encoding effects to occur. In the present study, the verbal and visual tasks were counterbalanced; therefore, the face presentation did not interfere with the word recall task and vice versa. However, another experiment could eliminate possible interference between the visual and verbal tasks.

A study by Berto [35] tested whether exposure to restorative vs. non-restorative scenes affected the process of memory encoding and/or retrieval by assessing participants' performance on a free recall and a recognition task. It was shown that exposure to the restorative vs. non-restorative scenes had no effect at all on the free recall and recognition performance in the encoding condition. On the contrary, in the retrieval condition, the restorative group produced a significantly lower number of intrusions for the free recall task, and the mean reaction times in the recognition task were significantly faster than in the non-restorative group [35]. Though there were certain limitations (e.g. the study did not provide information about the memory capacity prior to the study), results for the encoding condition and the verbal material were clear-cut: there was no effect, whereas they highlighted the potentially positive impact that restorative scenes can have on the retrieval process.

That said, one conclusion can be drawn for the encoding results. It might be that five minutes of exposure to scenes high in fascination prior to encoding were not enough to significantly affect the encoding process of verbal and visual material, though this exposure was sufficient to affect attention [3]. The exposure time is a critical variable in the restoration process [22,36,37], and a person may pass through successive levels for a potentially long restorative experience [6,38] it is possible that our participants in the encoding condition did not have enough time to process through all the restoration phases. From this perspective, the exposure time seemed long enough to affect the visual recognition performance in the retrieval condition. There was a difference between visual face recognition and verbal free recall. Although, in the encoding condition, face recognition did not change for the reason explained above, in the retrieval condition, the trend was as expected. This might actually have occurred due to chance or, as shown in the literature on eyewitness memory, because episodic memory for unfamiliar faces declines more slowly than memory for words and objects [39], but it appeared that the SART heavily affected face recognition, which turned out to be more difficult when the subjects were mentally fatigued, and the restoration gained through the picture exposure was not immediately lost (Figure 2) but "kept" for use in the second recognition test. In the retrieval condition, the significant effect may have emerged because the exposure to the fascinating stimuli was closer to the time of the visual recognition task, and this could be the key to understanding how the restorative process could affect memory retrieval.

According to the Attention Restoration Theory [6] attentional fatigue occurs after intense and prolonged mental demand as the attentional mechanism that inhibits distractions becomes less effective. When one is mentally fatigued, one is not able to neglect unimportant stimuli and allocate focus to important stimuli. The retrieval process comprises the selection of important information to deal with the task and the inhibition of unimportant information. In the retrieval condition, exposure to the fascinating stimuli allowed the participants to rest and recover the inhibitory mechanism that directed attention depends on, previously fatigued by performing the sustained attention task. However, only the visual material benefited from restoration and only in the retrieval condition.

Although this study provides initial evidence of an effect of fascinating stimuli on memory, in particular on the retrieval process of visual material, a potential weakness is that all participants saw high-fascination stimuli in both conditions; this was not a problem in the encoding condition, where there was no effect, but it could be a problem in the retrieval condition. In fact, one may question whether, in the retrieval condition, recognition performance would have improved even if no fascinating stimuli were shown just because the subjects got a break. This point emerged when planning the study, and the decision to focus only on high-fascination stimuli derived from a few considerations. First, Berto [3] showed that exposure to geometrical patterns, i.e. effortless material, had no effect at all (no improvement and no decrease) on the subjects' attentional performance; second, Berto et al. [5] showed that only in the high-fascination condition was subjects' performance of an attention-orienting task facilitated, whereas no effect occurred in the low-fascination condition. For these reasons, we decided to consider only high-fascination material. However, it is important to note that, in the present study, the fascinating effect was selective for visual material; in fact, the retrieval process of verbal material did not benefit from exposure to the fascinating material. At this point, an experiment in which the subjects see low-fascination stimuli and/or different effortless material in a between- or within-subjects design can clear any doubts concerning the process and the type of material; in fact, visual recognition could benefit from exposure to different effortless material and/or worsen because of exposure to low-fascination stimuli. Results could also be different whether only natural scenes high in fascination would have been used. Finally, though our aim was not to compare memory performance between genders, the small number of males limits the sample representativeness and the findings hold particularly for females.

Conclusion

Humans have the capacity to store a vast amount of information, and they depend on the capacity to retrieve the information under quite different circumstances [40]. Selection pressures in the evolutionary history of our species have promoted the efficient processing of faces [39]. Recognition can be difficult, but it is a central feature and functional requirement of human evolution [41]. Recognizing patterns of information (e.g. faces or objects) is direct and immediate rather than indirect and inferential; this means that humans deal with whole items rather than parts, and as a product of evolution, humans have learned to handle information patterns [40]. Although the approach we have taken is aligned with an information-processing perspective, it is important to note that this position emphasizes parts rather than wholes, and this is far from the position of environmental psychology. This is the key disagreement between Gibson [42] and the information processing perspective. Gibson argued that perception is direct and immediate, and no inference is needed. He admitted the importance of perceptual learning but not of memory. Gibson [42] was concerned with the effectiveness of visual perception in picking up the sort of information that one might need to function in the physical environment, a world far removed from the light-dots, letters, and numbers that dominate the stimulus patterns of information processing research [40]. Taking this perspective, the recognition of faces seems to be a task that is more "ecological" than the encoding and retrieval of words.

The present laboratory study does not claim to explain the effects of the Attention Restoration Theory on memory mechanisms; it simply wants to be a new direction in research on the mechanisms and effects that underlie the restorative benefits of interacting with fascinating stimuli, encouraging further research to explore environmental factors (and accordingly to plan therapeutic treatments) that could help restoring/optimizing cognitive resources, for example, in children with learning disabilities, elderly with memory impairment or adults with cognitive overload due to life stress.

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References

1. Tennessen CH, Cimprich B (1995) Views to nature: effects on attention. Journal of Environmental Psychology 1: 77-85.
2. Hartig T, Evans GW, Jamner LD, Davis DS, Garling T (2003) Tracking restoration in natural and urban settings. Journal of Environmental Psychology 23: 109-123.
3. Berto R (2005) Exposure to restorative environments helps restore the attention capacity. Journal of Environmental Psychology 25: 249-259.
4. Berman MG, Jonides J, Kaplan S (2008) The cognitive benefits of interacting with nature. Psychol Sci 19: 1207-1212.
5. Berto R, Baroni MR, Zainaghi A, Bettella S (2010) An exploratory study of the effect of high and low fascination environments on attentional fatigue. Journal of Environmental Psychology 30: 494-500.
6. Kaplan S (1995) The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology 15: 169-182.
7. James W (1892) Psychology: The briefer course. New York, NY: Holt.
8. Berto R (2014) The role of nature in coping with psycho-physiological stress. A literature review of restorativeness. Behavioral Science, special issue: Advances in Environmental Psychology 4: 394-409.
9. Kaplan R, Kaplan S, Ryan RL (1998) With people in mind. Design and managing of everyday nature. Washington, DC, Covelo, CA: Island Press.
10. Craik FJI, Lockart RS (1972) Levels of processing: A framework for memory research. Journal of Verbal Memory and Verbal Behavior 11: 56-72.
11. Downing PE (2000) Interactions between visual working memory and selective attention. Psychol Sci 11: 467-473.
12. Kahneman D (1973) Attention and effort. Englewood Cliffs, NJ: Prentice-Hall.
13. Kleinsmith LJ, Kalpan S (1963) Paired-associate learning as a function of arousal and interpolated interval. J Exp Psychol 65: 190-193.
14. Kleinsmith LJ, Kaplan S (1964) The interaction of arousal and recall interval in nonsense syllable paired associate learning. Journal of Experimental Psychology 67: 124-126.
15. Kleinsmith LJ, Kaplan S, Tarte RD (1963) The relationship of arousal to short- and longterm verbal recall. Can J Psychol 17: 393-397.
16. Lang PJ, Greenwald MK, Bradley MM, Hamm AO (1993) Looking at pictures: affective, facial, visceral, and behavioral reactions. Psychophysiology 30: 261-273.
17. Broadbent DE (1958) Perception and communication. London, UK: Pergamon Press.
18. Bradley MM, Greenwald MK, Petry MC, Lang PJ (1992) Remembering pictures: Pleasure and arousal in memory. Journal of Exper imental Psychology: Learning, Memory & Cognition 18: 379-390.
19. Rapaport D (1971) Emotions and memory. New York, NY: International University Press.
20. Fiedler K, Stroehm W (1986) What kind of mood influences what kind of memory: the role of arousal and information structure. Mem Cognit 14: 181-188.
21. Ulrich RS (1979) Visual landscapes and psychological well-being. Landscape Research 4: 17-23.
22. Hartig T, Mang M, Evans GW (1991) Restorative effects of natural environment experiences. Environment and Behavior 23: 3-26.
23. Hartig T, Nyberg L, Nilsson L, Garling T (1999) Testing for mood congruent recall with environmentally induced mood. Journal of Environmental Psychology 19: 353-367.
24. Korpela MK, Hartig T (1996) Restorative qualities of favorite places. Journal of Environmental Psychology 1: 249-258.
25. Purcell AT, Peron E, Berto R (2001) Why do preferences differ between scene types? Environment and Behavior 33: 93-106.
26. Pasini M, Berto R, Scopelliti M, Carrus G (2009) Measuring the restorative qualities of the environment: Contribution to the validation of the Italian version of the Perceived Restorativeness Scale. Bollettino di Psicologia Applicata 257: 3-11.
27. Robertson IH, Manly T, Andrade J, Baddeley B, Yiend J (1997) Oops! Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. Neuropsychologia 35: 747-758.
28. Manly T, Robertson IH, Galloway M, Hawkins K (1999) The absent mind: Further investigations of sustained attention to response. Neuropsychologia 37: 661-670.
29. McKone E, Kanwisher N, Duchaine BC (2007) Can generic expertise explain special processing for faces? Trends Cogn Sci 11: 8-15.
30. Bartlett JC, Sastri KS, Abdi H, Neville-Smith M (2009) Component structure of individual differences in true and false recognition of faces. Journal of Experimental Psychology: Learning, Memory and Cognition 35: 1207-1230.
31. Barca L, Burani C, Arduino LS (2002) Word naming times and psycholinguistic norms for Italian nouns. Behavior Research Methods, Instruments, & Computers 3: 424-434.
32. Burani C, Barca L, Arduino LS (2001) Una base di dati sui valori di età di acquisizione, frequenza, familiarità, immaginabilità, concretezza, e altre variabili lessicali e sub-lessicali per 626 nomi dell'italiano. Giornale Italiano di Psicologia 4: 839-854.
33. Alexander AI, Mayfield J (2005) Latent factor structure of the Test of Memory and Learning in a pediatric traumatic brain injured sample: support for a general memory construct. Arch Clin Neuropsychol 20: 587-598.
34. Berto R, Massaccesi S, Pasini M (2008) Do eye movements measured across high and low fascination photographs differ? Addressing Kaplan's fascination hypothesis. Journal of Environmental Psychology 28: 185-191.
35. Berto R (2004) The effect of the restorative environments on performance. A study on attention, perception and memory. Unpublished Doctoral Dissertation. University of Padova (Italy).
36. Hartig T, Böök A, Garvill J, Olsson T, Gärling T (1996) Environmental influences on psychological restoration. Scand J Psychol 37: 378-393.
37. Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, et al. (1991) Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology 1: 201-230.
38. Kaplan R, Kaplan S (1989) The experience of nature. A psychological perspective. New York, NY: Cambridge University Press.
39. Deffenbacher KA, Bornstein BH, McGorty EK, Penrod SD (2008) Forgetting the once-seen face: estimating the strength of an eyewitness's memory representation. J Exp Psychol Appl 14: 139-150.
40. Kaplan S, Kaplan R (1981) Cognition and the environment. Functioning in an uncertain world. Ann Arbor MI: Ulrich's.
41. Kaplan S (1972) The challenge of environmental psychology: a proposal for a new functionalism. Am Psychol 27: 140-143.
42. Gibson JJ (1979) The ecological approach to visual perception. Boston, MA: Houghton Mifflin.