



## CONNECTEDNESS AND WELL-BEING IN SIMULATED NATURE

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Abstract:	<p>People relate to nature physically, cognitively and emotionally, and this relationship fosters their well-being. There are various types of environment according to their degree of human intervention, raising the question of whether they each exert different effects on people, connectedness and well-being. In order to study the extent to which environmental connectedness and well-being are a function of viewing different types of nature, we conducted a study with 454 participants from five different countries, who viewed images on a computer screen of one of three types of environment (totally natural, quasi-natural or non-natural) and responded to a series of associated items. The results of a mediation analysis showed an indirect effect of type of environment on happiness through positive and negative affect and connectedness to nature. The corresponding ANOVAs revealed differences in the connectedness and well-being elicited by different types of environment, and in preference: totally natural and quasi-natural environments (with no differences between them) showed differences with non-natural environments. Therefore, our study results suggest that simply looking at natural environments on a computer screen arouses higher levels of well-being than viewing images of non-natural environments, and the former elicit a greater feeling of connectedness.</p>

# CONNECTEDNESS AND WELL-BEING IN SIMULATED NATURE

## Effects of simulated nature

### ABSTRACT

People relate to nature physically, cognitively and emotionally, and this relationship fosters their well-being. There are various types of environment according to their degree of human intervention, raising the question of whether they each exert different effects on people, connectedness and well-being. In order to study the extent to which environmental connectedness and well-being are a function of viewing different types of nature, we conducted a study with 454 participants from five different countries, who viewed images on a computer screen of one of three types of environment (totally natural, quasi-natural or non-natural) and responded to a series of associated items. The results of a mediation analysis showed an indirect effect of type of environment on happiness through positive and negative affect and connectedness to nature. The corresponding ANOVAs revealed differences in the connectedness and well-being elicited by different types of environment, and in preference: totally natural and quasi-natural environments (with no differences between them) showed differences with non-natural environments. Therefore, our study results suggest that simply looking at natural environments on a computer screen arouses higher levels of well-being than viewing images of non-natural environments, and the former elicit a greater feeling of connectedness.

Key words: naturalness, connectedness to nature, well-being, preference

### 1. INTRODUCTION

Throughout time and cultures, people have believed that contact with nature is beneficial to health and that natural elements such as plants or water have the capacity to alleviate anxiety and help us to cope with everyday stress (e.g. Hartig, Mang & Evans, 1991). This belief has even led to the extreme of viewing nature as a product advertised and sold for its positive effects. Research has shown that contact with nature increases levels of subjective well-being (e.g. Marselle, Irvine & Warber, 2014) and positive affect (Izenstark, Ravindran, Rodriguez & Devine, 2021), reduces stress (e.g. Tyrväinen et al., 2014) and improves human cognition (e.g. Berman, Jonides & Kaplan, 2008; Mayer, Frantz,

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3 Bruehlman-Senecal & Dolliver, 2009). Thus, well-being has become one of the most popular  
4 variables in environmental psychology (Olivos & Clayton, 2017).  
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6 Various theories have been proposed to explain this effect of nature. For example,  
7 Ulrich's stress reduction theory (1979) states that contact with nature promotes people's  
8 health by helping to alleviate the stress of everyday life. In contrast to the stress response,  
9 restoration includes numerous positive psychological changes, based on an evolutionary  
10 preference for natural environments. Meanwhile, Kaplan and Kaplan's (1989) attention  
11 restoration theory states that nature has the capacity to replenish attention levels fatigued by  
12 the cognitive effort involved in prolonged attention, by means of unconscious processes  
13 triggered by the presence of natural environments, because interaction with nature requires  
14 the use of faculties of concentration that are not habitually employed. This theory has also  
15 been linked to a preference for natural environments (e.g. Korpela & Hartig, 1996), which  
16 may play an important role in facilitating restoration by attracting people to such  
17 environments (Herzog, Maguire & Nebel, 2003).  
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27 Lastly, Mayer et al. (2009) have proposed that contact with nature increases people's  
28 level of well-being due to connectedness with nature, which acts as a mediating mechanism  
29 between the two.  
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32 The study of subjective well-being has basically been guided by two concepts (Ryff &  
33 Keyes, 1995). The first of these uses life satisfaction—the degree to which people perceive  
34 their life as being close to their ideal of a good life—as an indicator of subjective well-being.  
35 The second refers to a predominance of positive over negative affect. Positive affect reflects  
36 the degree to which a person feels excited, active and alert, in a state of high energy, with  
37 maximum focus and pleasure (Watson, Clark & Tellegen, 1988). Negative affect is a state  
38 of distress and displeasure, and includes moods such as anger, contempt, disgust, guilt, fear  
39 and anxiety. Both dimensions, however, have been found to be independent, and therefore  
40 the balance between them has been taken as an index of happiness (Ryff, 1989).  
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48 These three factors have been linked to contact with nature (Biedenweg, Scott & Scott,  
49 2017; Mayer et al., 2009). However, it is not always possible for people to access nature  
50 because of changes in how we now live: the majority of day-to-day tasks are performed in  
51 an urban world and people frequently lack sufficient time or resources to engage in activities  
52 in non-urban natural spaces.  
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56 Given many people's distance from the rural world, simulated nature may provide an  
57 alternative for those for whom contact with real nature is not possible, as it has also been  
58 shown to have beneficial effects. Several studies on the effect of simulated contact with  
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3 nature via video (Laumann, Gärling & Stormark, 2003), sounds (Alvarsson, Wiens &  
4 Nilsson, 2010) and photographs (Berto, 2005) have reported positive effects of such contact.  
5 In a study of sounds, for example, Haga, Halin, Holmgren and Sörqvist (2016) found that  
6 participants' simple belief that the sound they were hearing came from nature aroused higher  
7 levels of well-being than when they believed it came from a city. Thus, the meanings people  
8 attribute to nature and what they subjectively consider natural may affect the capacity of  
9 nature to enhance well-being.

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11 In this respect, it has been found that people distinguish between various types of  
12 natural environment based on their degree of human intervention (Mausner, 1996; Pasca,  
13 Aragonés & Fraijo, 2020). Thus, environments lie on a continuum from most to least human-  
14 intervened, each possessing different characteristics. Taking this variable into account, the  
15 extreme (totally natural and non-natural) and intermediate (quasi-natural) categories have  
16 been shown to be well and identically defined in two different cultural contexts. This raises  
17 the question of whether each of them exerts a different effect on people, connectedness and  
18 well-being, along the lines indicated by Carrus et al. (2013), who found that people perceive  
19 different degrees of restorative potential according to each environment's degree of  
20 naturalness.

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22 Consequently, the aim of our study was to examine the extent to which people's well-  
23 being is influenced by looking at different types of environment, and to determine their  
24 preference for and connectedness with these.

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### 2. Pilot study

In order to achieve our objective, we conducted an initial pilot study to select the stimuli for our study, in which simulated nature would be investigated by means of photographs.

#### 2.1 Method

##### 2.1.1 Participants

A total of 35 students from the Faculty of Psychology at the Complutense University of Madrid (Spain) participated in the selection of stimuli for this study.

##### 2.1.2 Instruments and procedures

First, 30 photographs were selected based on Mausner's (1996) definition of the extreme and intermediate categories of different environments ("totally natural", "quasi-natural" and "non-natural"), which have subsequently been shown to be perceived differently in terms of degree of naturalness (Pasca et al., 2020). To this end, we conducted

a search on Google to identify public domain photographs of high quality, since they would subsequently require enlargement.

Participants then answered an online questionnaire in which they had to evaluate each of the 30 photographs, the first 10 of which belonged to the “totally natural” category, the next 10 to the “quasi-natural” category and the last 10 to the “non-natural” category. Four photographs from the same category, validated in a previous study (Pasca et al., 2020), appeared at the top of the screen. Below these images appeared one of the new photographs selected for evaluation, theoretically corresponding to the same category as the four shown above. At the bottom of the screen, participants had to indicate the extent to which the photograph shown below belonged to the same category as the four shown above, using a 7-point scale where 1 meant not at all and 7 meant very much. They evaluated each of the 30 photographs using the same procedure.

## 2.2 Results

Thirty t-tests were performed for one sample, comparing the mean category membership of each photograph against a value of 3.5 (mean value on the rating scale). As shown in Table 1, we selected the five photographs from each category whose means showed the greatest statistically significant positive differences with the test value. Thus, photographs 2, 3, 4, 6 and 8 were selected for the “totally natural” category; 11, 12, 14, 15 and 16 for the “quasi-natural” category; and 21, 23, 24, 26 and 28 for the “non-natural” category.

*Table 11: mean differences with the test value of 3.5*

Photograph	M	SD	T	Difference t means
1	4,31	1,69	2,84	0,81**
2	5,17	1,42	6,94	1,67**a
3	4,69	1,43	4,90	1,19**a
4	5,29	1,47	7,20	1,79**a
5	4,34	1,64	3,03	0,84**
6	5,86	1,22	11,47	2,36**a
7	4,31	1,49	3,23	0,81**
8	4,57	1,63	3,88	1,07**a
9	4,00	1,46	2,03	0,50
10	3,46	1,60	-0,16	-0,04
11	6,49	0,82	21,60	2,99**a
12	6,00	1,14	13,00	2,50**a
13	4,57	1,20	5,30	1,07**
14	5,83	0,82	16,76	2,33**a
15	5,63	0,84	14,94	2,13**a
16	6,17	0,92	17,12	2,67**a

17	5,06	1,06	8,73	1,56**
18	4,69	1,43	4,90	1,19**
19	5,40	1,03	10,86	1,90**
20	3,74	1,92	0,75	0,24
21	5,43	1,67	6,84	1,93**a
22	3,91	1,87	1,31	0,41
23	5,66	1,03	12,42	2,16**a
24	5,77	1,26	10,65	2,27**a
25	3,77	1,85	0,87	0,27
26	5,40	1,14	9,84	1,90**a
27	4,94	1,51	5,64	1,44**
28	5,34	1,59	6,86	1,84**a
29	4,23	1,73	2,49	0,73*
30	4,51	1,69	3,56	1,01**

Note. Photographs 1-10 belong to the “totally natural” category, 11-20 to the “quasi-natural” category and 21-30 to the “non-natural” category.

Test value = 3.5

\* $p < 0.05$ ; \*\* $p < 0.01$

a = photograph selected for study 1

### 3. Study 1

After selecting the study stimuli, we performed a further study to examine the extent to which people’s well-being is influenced by viewing different types of environment and determine their preference for and connectedness to these. We adopted a mediational model, hypothesising that positive and negative affect and connectedness to nature can act as mediators in explaining happiness according to different types of environment.

#### 3.1 Method

##### 3.1.1 Participants

Study participants comprised 454 students from five countries: Spain ( $n = 93$ ), Mexico ( $n = 92$ ), Italy ( $n = 96$ ), France ( $n = 88$ ) and Portugal ( $n = 85$ ). Of these, 78.4% were women, and the mean age was 20.92 ( $SD = 3.15$ ). Data can be found on the Open Science Framework <https://osf.io/ucr86/>.

##### 3.1.2 Design

We used an experimental design in which participants from each country were randomly assigned to one of three experimental groups (Table 2): “totally natural” condition, “quasi-natural” condition and “non-natural” condition.

Table 2: sample size for each condition by country

Country	Condition	N
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Spain	Totally natural	30
	Quasi-natural	30
	Non-natural	33
Mexico	Totally natural	32
	Quasi-natural	30
	Non-natural	30
Italy	Totally natural	34
	Quasi-natural	30
	Non-natural	32
France	Totally natural	30
	Quasi-natural	28
	Non-natural	30
Portugal	Totally natural	28
	Quasi-natural	30
	Non-natural	27

### 3.1.3 Instruments and procedures

In this study, we used the 15 photographs (see Figure 1) obtained for the three nature categories.

A software was designed with three versions (“totally natural”, “quasi-natural” and “non-natural”), each containing images from the corresponding environment category. The software presented the first of the five photographs from the corresponding category for 30 seconds in full-screen mode. Then, the next screen opened automatically, displaying the same image at a reduced size followed by an item adapted from the INS (Schultz, 2001) asking about the degree to which the participant felt included in the landscape shown, and another item in visual analogue scale format from 0 to 100, asking about the degree of happiness that it aroused in the participant. Next, the second image was shown for 30 seconds, and the same procedure was followed until all five photographs corresponding to the category had been presented. Once the five photographs and their corresponding items had been presented, we continued with a new situation in which connectedness to nature was measured using a reduced 7-item version of the CNS scale (Pasca, Aragonés & Coello, 2017).

Instead of presenting all scale items together on a single screen, each item was presented separately on consecutive screens. Following the onscreen instruction “taking into account the following landscapes...”, each of the five images that participants had viewed previously were shown again with the corresponding item beneath. Subsequently, following the same format as in the previous scale and presenting the same five photographs, the adaptation by López-Gómez, Hervás and Vázquez (2015) of the positive and negative affect scale (PANAS) was presented, with each item appearing separately in sequence. Finally, to

measure preference, participants were asked on a new screen to rate how much they liked each of the landscapes, one by one.

The software required installation in a computer classroom, where participants completed the tests, and was translated from the Spanish version into the vernacular language of each country.



Figure 1. Example of photographs used in the software

### 3.2 Results

To test our meditational hypotheses concerning the relationship between naturalness and happiness, we used the PROCESS macro for SPSS (Hayes, 2013), which simultaneously tested the role of positive and negative affect, as well as CNS, as mediators. A bootstrapping procedure (with 5,000 bootstrap samples) was used to estimate 95% bias-corrected confidence intervals (bias-corrected; BC 95% CI). A BC 95% CI that does not include zero provides evidence of a significant indirect effect (MacKinnon, Krull, & Lockwood, 2000; Preacher & Hayes, 2008). As shown in Figure 1, the model provided estimates of the total, direct, and indirect effects of the naturalness on happiness through positive and negative mood and CNS. Mediating analyses revealed significant indirect effects of naturalness on happiness through positive mood (point estimate = 1.82, BC 95% CI = 0.89 to 2.93), negative mood (point estimate = 0.77, BC 95% CI = 0.13 to 1.53) and CNS (point estimate = 0.47, BC 95% CI = 0.08 to 1.03) (see Figure 2).



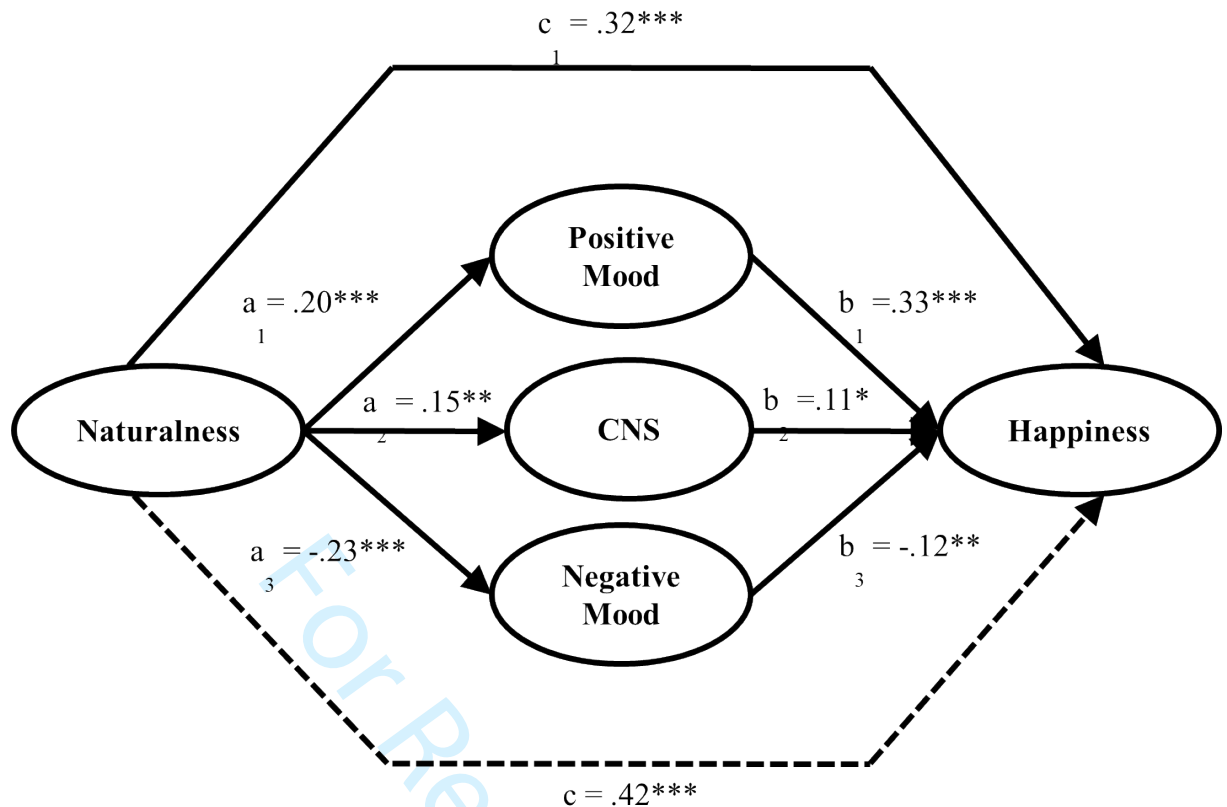


Figure 2. Mediation model, showing the effect of naturalness on happiness through positive and negative mood and connectedness to nature. NOTE: Path values represent standardised regression coefficients. The (c1) value represents the effect, from bootstrapping analyses, of naturalness on happiness after the mediators are included. Dotted line (c) represents the effect of naturalness on happiness prior to inclusion of the mediating variables. \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

We further investigated whether our mediating model was affected by the addition of covariates, such as participants' gender and age, and found that the indirect effects did not substantially change. None of the indirect effects 95% CIs contained 0. We found a positive and significant relationship between age and CNS ( $\beta = .15$ ,  $p < .0001$ ), whereas analyses showed a negative and significant relationship between age and negative mood ( $\beta = -.11$ ,  $p < .001$ ). Older participants showed a less negative mood and a greater CNS. We further tested whether the paths of the model (i.e. a1, b1, a2, b2, a3, b3, c; see Figure 1) varied as a function of the country where we collected the data. No evidence for significant interaction emerged (all  $p$ 's  $> .10$ ).

Second, we performed a two-factor ANOVA (type of environment x country) for each of the variables studied: connectedness, well-being and preference. The results (Table 3) indicated that the effect of each of the factors was statistically significant for all the variables analysed, whereas there was no statistically significant effect of the interaction between type of environment viewed and the participants' country, as had been found in the previous analysis.

*Table 3: two-factor ANOVA results for connectedness, well-being and preference*

Factor	F	Gf	Sig.	$\hat{\omega}^2$
Connectedness				
Type of environment	5,790	2,439	,003	,021
Country	12,597	4,439	,000	
Interaction	1,204	8,439	,295	
Positive affect				
Type of environment	13,282	2,439	,000	,051
Country	22,306	4,439	,000	
Interaction	1,287	8,439	,248	
Negative affect				
Type of environment	17,287	2,439	,000	,067
Country	11,774	4,439	,000	
Interaction	0,636	8,439	,748	
Happiness				
Type of environment	63,659	2,439	,000	,216
Country	10,900	4,439	,000	
Interaction	1,426	8,439	,183	
Preference				
Type of environment	106,155	2,439	,000	,317
Country	8,710	4,439	,000	
Interaction	1,535	8,439	,143	

Therefore, only the main effects of type of environment were interpreted, since the main effects of country might be due to the way nature is understood and valued in each one (e.g. Pasca, Coello & Aragonés, 2018). The means for each of the variables for each of the three types of environment are shown in Table 4, where it can be seen that differences were found ( $p < 0.01$ ) between the group that viewed non-natural environments and the groups that viewed totally natural and quasi-natural environments.

Table 4: means (and standard deviations) in connectedness, well-being and preference for each type of environment

	Connectedness	Positive affect	Negative affect	Happiness	Preference
Totally natural	5,375 (0,073) <sup>a</sup>	3,268 (0,060) <sup>a</sup>	1,552 (0,052) <sup>a</sup>	64,122 (1,623) <sup>a</sup>	3,906 (0,058) <sup>a</sup>
Quasi-natural	5,297 (0,075) <sup>a</sup>	3,249 (0,061) <sup>a</sup>	1,583 (0,053) <sup>a</sup>	59,609 (1,653) <sup>a</sup>	3,566 (0,059) <sup>b</sup>
Non-natural	5,036 (0,074) <sup>b</sup>	2,880 (0,060) <sup>b</sup>	1,946 (0,053) <sup>b</sup>	39,650 (1,634) <sup>b</sup>	2,735 (0,059) <sup>c</sup>

Note: different superscripts in the same column denote statistically significant differences ( $p < 0.01$ ).

#### 4. CONCLUSION

Our results indicate, first, that viewing different types of environment arouses different degrees of happiness. This occurs through two mediational pathways. On the one hand, in line with the definition of happiness proposed by Ryff (1989), we found that happiness was explained by levels of positive and negative affect. Thus, different types of environment aroused different levels of positive and negative affect, determining the level of happiness of a person viewing a particular type of landscape. A similar result was reported by Foo (2016), who studied people's well-being in three forests distinguished by their degree of naturalness. Psychophysiological studies have also shown that natural environments are more restorative than built environments (Mahamane et al., 2020).

On the other hand, our mediational model showed that connectedness to nature is an intermediate variable between type of environment and happiness. This finding provides evidence for the model proposed by Mayer et al. (2009), which states that the higher levels of well-being aroused by natural environments are due to connectedness to nature. This relationship has been confirmed by Schnell, Harel and Mishori (2019), who found that people who felt more connected to nature showed higher levels of well-being, explaining 49% of the variance in well-being.

Second, the results of the analysis of variance revealed where the differences between the environments lie. In terms of well-being, viewing natural environments arouses higher levels of well-being than viewing built environments, as has been shown in the literature (e.g. Hartig et al., 1991; Beute & de Kort, 2018). In our study, we observed a lower presence of negative affect, a higher presence of positive affect and a higher level of "happiness" in participants who viewed natural environments. However, we found no differences in well-

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3 being between participants viewing totally natural or quasi-natural environments. This  
4 indicates that although these are different categories of nature, their effect on people is  
5 similar. Hence, parks or gardens are often considered to represent nature, even in research  
6 conducted on nature (e.g. Bratman, Hamilton & Daily, 2012).  
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10 Besides the distinction between totally natural and quasi-natural environments, our  
11 results showed lower negative affect in people who had viewed natural images compared to  
12 those who viewed images of built environments. Similarly, the former also showed higher  
13 positive affect. According to Diener (1984), one of the conditions for characterising  
14 subjective well-being is that there should be not only low levels of negative affect, but also  
15 high levels of positive affect. Therefore, it can be concluded that the effect of simulated  
16 nature is related to subjective well-being.  
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22 Restoration theories have been associated with a preference for natural environments  
23 (e.g. Korpela, Hartig, Kaiser & Fuhrer, 2001), with people's preferred environments being  
24 more restorative. We observed this relationship in the present study, finding a greater  
25 preference for natural environments, which aroused higher levels of well-being.  
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29 Consequently, our study highlights the need to expose people to natural landscapes,  
30 for example through photographs or paintings of these environments, as opposed to images  
31 of urban environments.  
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