Supplementary Materials

Maximizing learning: Lesson-related wall decorations support learning while unrelated decorations do not hinder it

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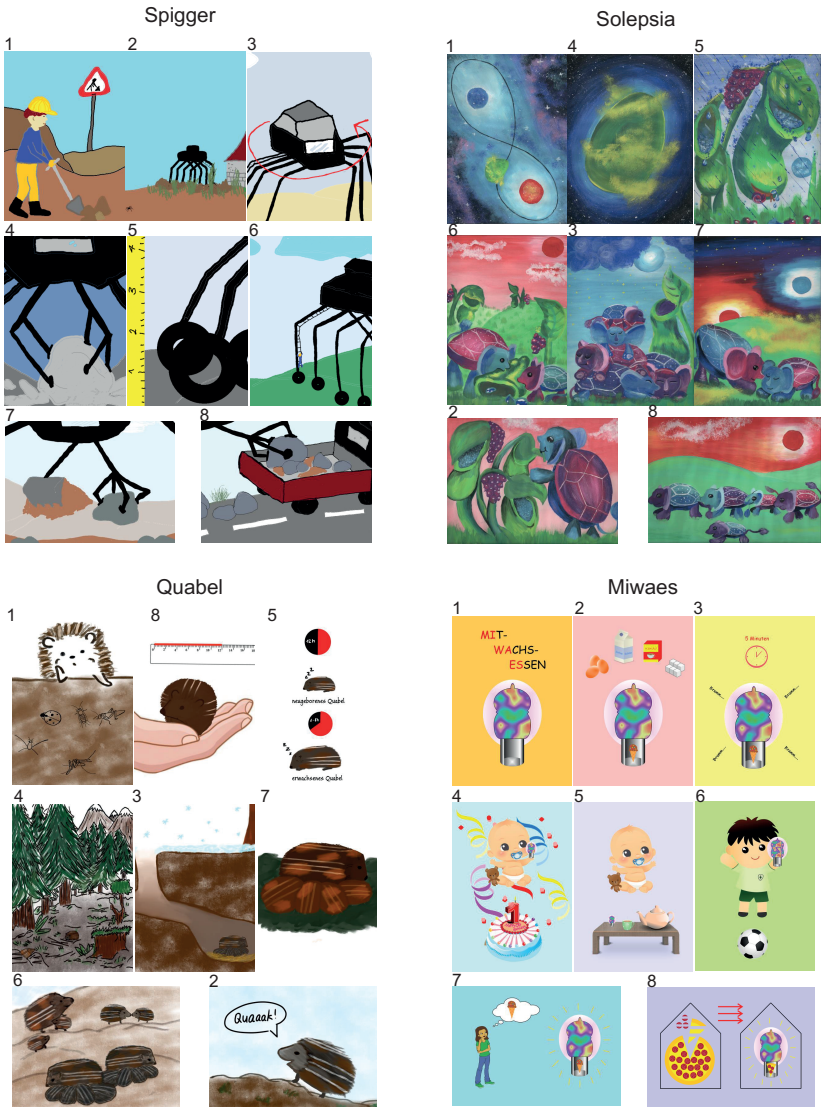
S1 Materials

S1.1 Pictures



S1.2 Sample materials: Example of a story (Solepsia)

The following sections present the story and the questions for one of the stories, the one about the planet Solepsia. The text has been translated from German.

Story. Solepsia is a planet in a faraway galaxy. The distance from earth to Solepsia is 930 lightyears. The planet moves around two suns in a figure eight shape. These suns are different from the sun that warms the earth because one sun is blue, and the other is red. That's why, depending on the position of the planet, a different coloured light shines on its surface. When the planet is in orbit right between the two suns, red light falls onto one side of the planet while blue light falls onto the other. The blue sun is called "Belarius". The red sun is named "Agilla". Solepsia is the size of a house and is shaped like an egg. The planet is engulfed in yellow fog. The fog smells a little like sulfur, like freshly lit matches. The surface of the planet is covered in green plants with funnel shaped blossoms and leaves. When it rains, water is collected in the funnels. The plants have a nutty smell and they pass their scent on to the water in the funnels. This is perfect for the five nosephants that live on the planet. The nosephants eat the funnel shaped leaves and at the same time quench their thirst. The nosephants have big noses and big ears. They sleep when the light of the blue sun falls on the planet. When the red sun shines, the nosephants wake up again. Because the planet is very small and the yellow fog is so thick, the nosephants often bump into each other. But that's ok because they love to cuddle. After it rained, the fog is less thick, and it smells less like sulfur. Then the nosephants can see better. They then gather in a group and rub their backs against each other. That's how they clean themselves.

S1.3 Test questions and assignments between images, questions, and correct answers

Table S1. Test questions for the example story Solepsia (1.2) and their assignment to the relevant information in the lecture (bold) and in the images.

Test questions	Relevant information in the lesson	Correct answer [number of required elements for max. score]	Relevant pictures (S1.1)
1.Which shape does the planet's orbit have? [Welche Form hat die Laufbahn des Planeten?]	"The planet moves around two suns in a **figure eight shape**."	**number eight shape** (around two suns) [1]	1
2. Which colours do the two suns have? [Welche Farben haben die beiden Sonnen, um die sich der Planet bewegt?]	"… **one sun is blue**, and **the other is red**" "That's why, depending on the position of the planet, a **different coloured light shines on its surface.**"	One sun is **blue**, the other is **red** [2]	1 7 (3,6,8 blue OR red sun)
3. Which shape does the planet have? [Welche Form hat der Planet?]	"Solepsia is the size of a house and is **shaped like an egg**"	shaped liked an **egg** [1]	1 4
4. Which colour does the fog have? [Welche Farbe hat der Nebel der die Planetenoberfläche umgibt?]	"The planet is **engulfed in yellow fog**." "[…] the **yellow** fog is so thick"	**yellow** fog [1]	1 4 (7 fog in the background)
5. Where is the rainwater collected? [Worin sammelt sich das Regenwasser?]	"The surface of the planet is covered **in green plants with funnel shaped blossoms and leaves**. **When it rains, water is collected in the funnels**."	In plants **with funnel shaped leaves** [2]	5 2
6. What do the Nasenfanten eat? [Wovon ernähren sich die Nasenfanten?]	"The Nasenfanten **eat the funnel shaped leaves** and at the same time quench their thirst."	they eat the **funnel-shaped leaves** and that way also quench their thirst [2]	2 6
7. How many Nasenfanten live on the planet? [Wie viele Nasenfanten leben auf dem Planeten?]	"[…] for the **five Nasenfanten that live on the planet**"	**Five** [1]	3 8

8. During what kind of sunlight do the Nasenfanten sleep? [Bei welchem Sonnenlicht schlafen die Nasenfanten?]	"**They sleep when the light of the blue sun falls on the planet**."	when the light of the **blue** sun shines on the planet [1]	3 7

S2 Background sounds

In order to create a more ecological classroom environment, distinct identifiable sounds were played in the background while children were listening to the stories. The analysis of the sound effects is not included in the present article.

Apparatus. We used an ASUS Notebook PC (Model GL752V; AUSTek Computer Inc.) with Software XUbuntu 16.04 to control the auditory stimulation. The sounds were sent via one speaker Bose Companion ® 2 (Series III, Bose Corporation Framingham, MA 01701 USA).

Materials. We used a total of 24 sounds taken from a pool of sounds used in previous experimental work with children, such as e.g., falling coins, tearing paper, siren of a passing police car, laughter of a child, coughing (Bonmassar et al., 2020). In turn, the 56-sound pool used by Bonmassar et al. (2020) was taken from a previously published 210-sound database (Max, Widmann, Kotz, Schröger, & Wetzel, 2015). The sounds had a duration of 500 ms and included a faded end of 5 ms. Root mean square normalization was used to equalize the sounds loudness among the sounds. These and other details about the sound are included in the original publication (Max et al., 2015). The sounds were played at a sound level pressure (SPL) of 72 dB (measured with PAA3 PHONIC Handheld audio analyzer, Phonic Corporation, Taipei, Taiwan) and can be found at the project's OSF page (https://osf.io/9mt8j).

The 24 sounds were split in three blocks of eight sounds for presentation purposes (see Procedure below). We ensured that the blocks did not differ in emotional valence (*M* set 1 = 4.33 [*SD* = 1.51]; *M* set 2 = 4.36 [*SD* = 1.36]; *M* set 3 = 4.35 [*SD* = 1.51] or arousal (*M* set 1 =

5.50 [*SD* = 1.54]; *M* set 2 = 5.50 [*SD* = 1.51]; *M* set 3 = 5.50 [*SD* = 1.51]), according to the ratings of the original database in a 9-point Likert scale (Max et al., 2015).

Procedure. The sounds were grouped into three blocks, such that children listened to one block during each of the stories. The order of the sound sets was randomized in order to avoid confounding effects with the stories. We pseudorandomized the presentation time of the sounds to make them fully unpredictable. The only restriction for sound presentation were that the first sound was presented at least 16.5 seconds after the lesson began, and that a minimum of 16.5 seconds occurred in between two sounds. Mean stimulus onset asynchrony (SOA) of the sounds was of 21.88 seconds (*SD* = 6.21; range = 16.50-46.20) during lesson 1, of 21.97 (*SD* = 6.37; range = 16.50-46.20) during lesson 2, and of 22.04 (*SD* = 5.93; range = 16.50-42.90), during lesson 3.

S3 Supplementary analyses

S3.1 Fixation count

Relative fixation count: For the count measure, we summed the total amount of fixations to a specific AOI and divided it by the total number of fixations in the trial (i.e., in the whole lesson).

Table S2. Relative fixation count as a function of AOI in the different wall decoration conditions. Part a) shows descriptive statistics (mean and standard error of the mean), and part b) the output of the ANOVA with fixation count as dependent variable and wall decoration (*empty*, *unrelated* and *related*) and AOI (*other, teacher and picture*) as independent variables. Parts c) and d) show the output of the simple effect contrasts, where *p*-values are adjusted with Holm's correction for three tests.

a) Descriptive statistics

	AOI		
	Other	Teacher	Picture
Decoration	% *M* (*SE*)		
Empty	.32 (.04)	.61 (.04)	.07 (.01)
Unrelated	.15 (.02)	.34 (.04)	.51 (.05)
Related	.13 (.02)	.20 (.03)	.67 (.04)

b) Repeated-measures *ANOVA*

Predictor	*dfNum*	*dfDen*	*F*	*p*	η_g^2
(Intercept)	1.00	35.00	2682981.53	<.001	.74
Decoration	1.85	64.67	0.03	.96	.00
AOI	1.38	48.44	13.34	<.001	.19
Decoration * AOI	2.87	100.49	78.64	<.001	.46

c) Simple effect contrasts: differences in fixation count between AOIs within the levels of the wall decoration factor

Decoration	AOI contrast	Estimate	*t*-value	*p*-value
Empty	Other vs. Teacher	-28.20	-4.94	<.001
	Other vs. Picture	24.90	4.36	<.001
	Teacher vs. Picture	53.20	9.30	<.001
Unrelated	Other vs. Teacher	-19.20	-3.35	.002
	Other vs. Picture	-36.60	-6.39	<.001
	Teacher vs. Picture	-17.40	-3.04	.003
Related	Other vs. Teacher	-6.50	-1.14	.26

Other vs. Picture	-53.30	-9.32	<.001
Teacher vs. Picture	-17.40	-8.19	<.001

d) Simple effects contrasts: differences in fixation count between the wall decoration conditions within the levels of the AOI factor

AOI	Decoration contrast	Estimate	*t*-value	*p*-value
Other	Empty vs. Unrelated	17.47	4.92	<.001
	Empty vs. Related	18.83	5.31	<.001
	Unrelated vs. Related	1.36	0.38	.70
Teacher	Empty vs. Unrelated	26.53	7.48	<.001
	Empty vs. Related	40.56	11.43	<.001
	Unrelated vs. Related	14.03	3.95	<.001
Picture	Empty vs. Unrelated	-44.03	-12.41	<.001
	Empty vs. Related	-59.42	-16.74	<.001
	Unrelated vs. Related	-15.39	-4.34	<.001

S3.2 ANCOVA including age as covariate

S3.2.1 Accuracy

The ANCOVA with the factors wall decoration (*empty, unrelated and related*), time (*immediate, follow-up*) and the covariate age (centered following Schneider et al., 2015) revealed a main effects of wall decoration ($F(2,66) = 6.77$, $p = .002$, $\eta_g^2 < .068$) and time ($F(1,34) = 5.95$, $p = .02$, $\eta_g^2 = .007$). None of the other main effects or interactions revealed statistical significance, except the interaction time × age ($F(1,34) = 4.27$, $p = .046$, $\eta_g^2 = .005$), indicating increasing difference between immediate and follow-up tests with increasing age.

However, this side result was not in the focus of the study and the study was not designed to investigate age differences.

S3.2.2 Duration fixation

The ANCOVA with the factors wall decoration (*empty, unrelated and related*), gaze direction (*other, teacher and picture*) and the covariate age (centered, Schneider et al., 2015) revealed a main effect of gaze direction ($F(1,44) = 13.28$, $p < .001$, $\eta_g^2 = .19$) and an interaction between the factors gaze direction and wall decoration ($F(3,98) = 64.58$, $p < .001$, $\eta_g^2 = .42$). None of the other effects revealed statistical significance.

S3.3 ANCOVA including number of follow-up days as covariate

Since the number of days between the immediate and the follow-up test varied (mean 7.67, SD = 2.14, min = 5, max = 15 days) we added the number of follow-up days as covariate (centred) to an ANOVA with the factors wall decoration (*empty, unrelated and related*) and time point (*immediate* and *follow-up*). The pattern of results did not significantly changed: main effect wall decoration ($F(2,65) = 6.60$, $p < .01$, $n_P^2 = .163$), main effect time point ($F(1,34) = 5.28$, $p = .028$, $n_P^2 = .134$). None of the other main effects or interactions revealed statistical significance. Importantly, there was no interaction between time point and number of days ($F<1$).

References

Schneider B.A., Avivi-Reich, M. and Mozuraitis, M. (2015). A cautionary note on the use of the Analysis of Covariance (ANCOVA) in classification designs with and without within-subject factors. *Front. Psychol*. 6:474. doi: 10.3389/fpsyg.2015.00474.