Supplementary Material

Age differences in generalization, memory specificity, and their overnight fate in childhood

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Supplementary Table 1

Sample description grouped by age in years

Age (yrs)	n_{total}	$n_{In\text{-}person}$	n_{online}	m_{age}	n_{male}	n_{female}
4	35	15	20	4.42	17	18
5	28	12	16	5.55	14	14
6	20	6	14	6.54	8	12
7	20	4	16	7.41	10	10
8	38	18	20	8.61	21	17

Note. Mean age is reported in yy.mm. For descriptive purposes, children are grouped by age in years. However, note that we treated age as a continuous variable in all analyses unless indicated otherwise.

Supplementary Table 2

Results from independent t-tests comparing performance accuracy during the immediate test between online and in person tested children

		In-person			Online						
Age (yrs)	Subtask	n_1	M_1	SD_1	n_2	M_2	SD_2	t	df	p	Cohen's d
4	GEN	15	0.47	0.14	20	0.46	0.11	0.22	24.96	0.824	0.08
	CNTX	15	0.43	0.13	20	0.41	0.13	0.38	29.81	0.709	0.13
	CON SPEC	15	0.58	0.19	20	0.64	0.19	-0.98	30.52	0.334	-0.33
	PER SPEC	15	0.46	0.16	20	0.44	0.13	0.45	26.65	0.658	0.16
8	GEN	18	0.93	0.05	20	0.90	0.09	1.07	32.21	0.291	0.34
	CNTX	18	0.66	0.17	20	0.68	0.13	-0.45	31.85	0.652	-0.15
	CON SPEC	18	0.86	0.14	20	0.86	0.12	-0.10	34.40	0.922	-0.03
	PER SPEC	18	0.60	0.17	20	0.52	0.13	1.73	32.52	0.093	0.57

Note. Statistical comparisons between online and in-person performance was only conducted for the 4- and 8-year-olds due to a low number of 5-, 6-, and 7-year-olds children tested in-person. Degrees of freedom (*df*) were corrected using Welch's method in case of unequal variances. *n* = sample size, *M* = mean, *SD* = standard deviation, GEN = generalization, CNTX = context binding, CON SPEC = item conceptual specificity, PER SPEC = item perceptual specificity.

Supplementary Table 3

Results from independent t-tests comparing performance accuracy during the delayed test between online and in person tested children

		In-person			Online						
Age (yrs)	Subtask	n_1	M_1	SD_1	n_2	M_2	SD_2	t	df	p	Cohen's d
4	GEN	15	0.44	0.10	20	0.42	0.18	0.35	31.53	0.73	0.11
	CNTX	15	0.40	0.14	20	0.36	0.13	0.76	28.69	0.45	0.26
	CON SPEC	15	0.67	0.28	20	0.81	0.16	-1.81	20.58	0.09	-0.64
	PER SPEC	15	0.50	0.16	20	0.39	0.15	2.00	29.34	0.05	0.69
8	GEN	18	0.89	0.12	20	0.89	0.10	0.05	34.20	0.96	0.02
	CNTX	18	0.63	0.12	20	0.67	0.13	-0.94	35.96	0.35	-0.30
	CON SPEC	18	0.99	0.03	20	0.99	0.02	-0.48	27.19	0.64	-0.16
	PER SPEC	18	0.60	0.20	20	0.52	0.15	1.42	31.30	0.16	0.47

Note. Statistical comparisons between online and in-person performance was only conducted for the 4- and 8-year-olds due to a low number of 5-, 6-, and 7-year-olds children tested in-person. Degrees of freedom (*df*) were corrected using Welch's method in case of unequal variances. *n* = sample size, *SD* = standard deviation, GEN = generalization, CNTX = context binding, CON SPEC = item conceptual specificity, PER SPEC = item perceptual specificity.

Supplementary Table 4

Post-hoc linear regression on the effect of age (months) on immediate generalization performance

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.11, 0.11]$	0.00	>.999
Age (months)	0.77	[0.66, 0.87]	14.02	< .001

Note. R^2 = 0.59, F = 196.53 on 1.00 and 139.00 degrees of freedom, CI= confidence interval of beta, LL= lower limit of CI, UL= upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 4.

Supplementary Table 5

Post-hoc linear regression on the effect of age (months) on immediate context binding performance

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.14, 0.14]$	0.00	>.999
Age (months)	0.55	[0.41, 0.69]	7.79	< .001

Note. R^2 = 0.30, F = 60.63 on 1.00 and 139.00 degrees of freedom, CI= confidence interval of beta, LL= lower limit of CI, UL= upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 4.

Supplementary Table 6

Post-hoc linear regression on the effect of age (months) on immediate item conceptual specificity performance

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.14, 0.14]$	0.00	>.999
Age (months)	0.50	[0.36, 0.65]	6.85	< .001

Note. R^2 = 0.25, F = 46.88 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 4.

Supplementary Table 7

Post-hoc linear regression on the effect of age (months) on immediate item perceptual specificity performance

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.16, 0.16]$	0.00	>.999
Age (months)	0.23	[0.07, 0.39]	2.81	.023

Note. R^2 = 0.05, F = 7.89 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 4.

Supplementary Table 8

Summary of the fixed effects from the linear mixed-effect model on retained items including the covariate "overall task performance"

	beta	95% CI [LL, UL]	*df*	*t*	*p*
(Intercept)	0.37	[0.26, 0.47]	278	6.82	<.001
Age (months)	0.09	[0.06, 0.12]	138	5.66	<.001
Context binding	0.07	[0.04, 0.11]	278	3.90	<.001
Item perceptual specificity	0.07	[0.03, 0.10]	278	3.49	.001
Overall task performance	0.56	[0.40, 0.72]	138	6.98	<.001
Age (months): Context binding	-0.07	[-0.11, -0.04]	278	-3.81	<.001
Age (months): Item perceptual specificity	-0.08	[-0.12, -0.04]	278	-4.05	<.001

Note. CI = confidence interval of beta, LL = lower limit of CI, UL= upper limit of CI, *df* = degrees of freedom.

Supplementary Table 9

Post-hoc linear regression on the effect of age (months) on retained generalization

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.13, 0.13]$	0.00	>.999
Age (months)	0.62	[0.49, 0.75]	9.29	< .001

Note. R^2 = 0.38, F = 86.25 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 10

Post-hoc linear regression on the effect of age (months) on retained context binding

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.15, 0.15]$	0.00	>.999
Age (months)	0.44	[0.29, 0.59]	5.74	< .001

Note. R^2 =0.19, F = 32.90 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 11

Post-hoc linear regression on the effect of age (months) on retained item perceptual specificity

Predictor	$beta$	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.16, 0.16]$	0.00	>.999
Age (months)	0.35	[0.20, 0.51]	4.46	< .001

Note. R^2 = 0.13, F = 19.92 on 1.00 and 139.00 degrees of freedom, CI= confidence interval of beta, LL= lower limit of CI, UL= upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 12

Summary of the fixed effects from the linear mixed-effect model on gain including the covariate "overall task performance"

	$beta$	95% CI [LL, UL]	*df*	*t*	*p*
(Intercept)	0.28	[0.16, 0.41]	260	4.39	<.001
Age (months)	0.06	[0.02, 0.10]	138	3.15	.002
Context binding	-0.38	[-0.43, -0.34]	260	-15.87	<.001
Item perceptual specificity	-0.32	[-0.37, -0.28]	260	-13.35	<.001
Overall task performance	0.40	[0.20, 0.59]	138	4.03	<.001
Age (months): Context binding	-0.10	[-0.15, -0.05]	260	-4.10	<.001
Age (months): Item perceptual specificity	-0.12	[-0.17, -0.07]	260	-4.94	<.001

Note. CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI, *df* = degrees of freedom.

Supplementary Table 13

Frequency distribution of children with evening performance of less than 3 items left to gain per age group and subtask

		Age (years)					Total (subtests at ceiling)
		4	5	6	7	8	
Subtask	Gen	0	2	11	8	29	50
	CNTX	0	0	0	0	2*	2
	PERSPEC	0	1	0	0	1*	2
	Total (children)	0	3	11	8	29	

Note. * = these children also showed ceiling performance in the generalization test; CNTX = context binding, PERSPEC = item perceptual specificity.

Supplementary Table 14

Summary of the fixed effects from the linear mixed-effect model on gain performance excluding performances close to ceiling per subtask

	beta	95% CI [LL, UL]	*df*	*t*	*p*
(Intercept)	0.52	[0.48, 0.56]	224	27.13	<.001
Age (months)	0.11	[0.07, 0.14]	139	5.38	<.001
Context binding	-0.36	[-0.41, -0.32]	224	-15.49	<.001
Item perceptual specificity	-0.31	[-0.35, -0.26]	224	-13.16	<.001
Age (months): Context binding	-0.10	[-0.15, -0.05]	224	-4.22	<.001
Age (months): Item perceptual specificity	-0.13	[-0.17, -0.08]	224	-5.28	<.001

Note. CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI, *df* = degrees of freedom.

Supplementary Table 15

Post-hoc linear regression on the effect of age (months) on gained generalization

Predictor	*beta*	95% CI [LL, UL]	$t(121)$	p_{adj}
Intercept	0.04	$[-0.13, 0.21]$	0.42	> .999
Age (months)	0.32	$[0.15, 0.49]$	3.73	< .001

Note. R^2 = 0.10, F = 13.90 on 1.00 and 121.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 16

Post-hoc linear regression on the effect of age (months) on gained context binding

Predictor	*beta*	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.17, 0.17]$	0.00	>.999
Age (months)	0.01	$[-0.15, 0.18]$	0.16	>.999

Note. R^2 = 0.00, F = 0.03 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 17

Post-hoc linear regression on the effect of age (months) on gained item perceptual specificity

Predictor	*beta*	95% CI [LL, UL]	$t(139)$	p_{adj}
Intercept	0.00	$[-0.17, 0.17]$	0.00	>.999
Age (months)	-0. 13	$[-0.29, 0.04]$	-1.52	.390

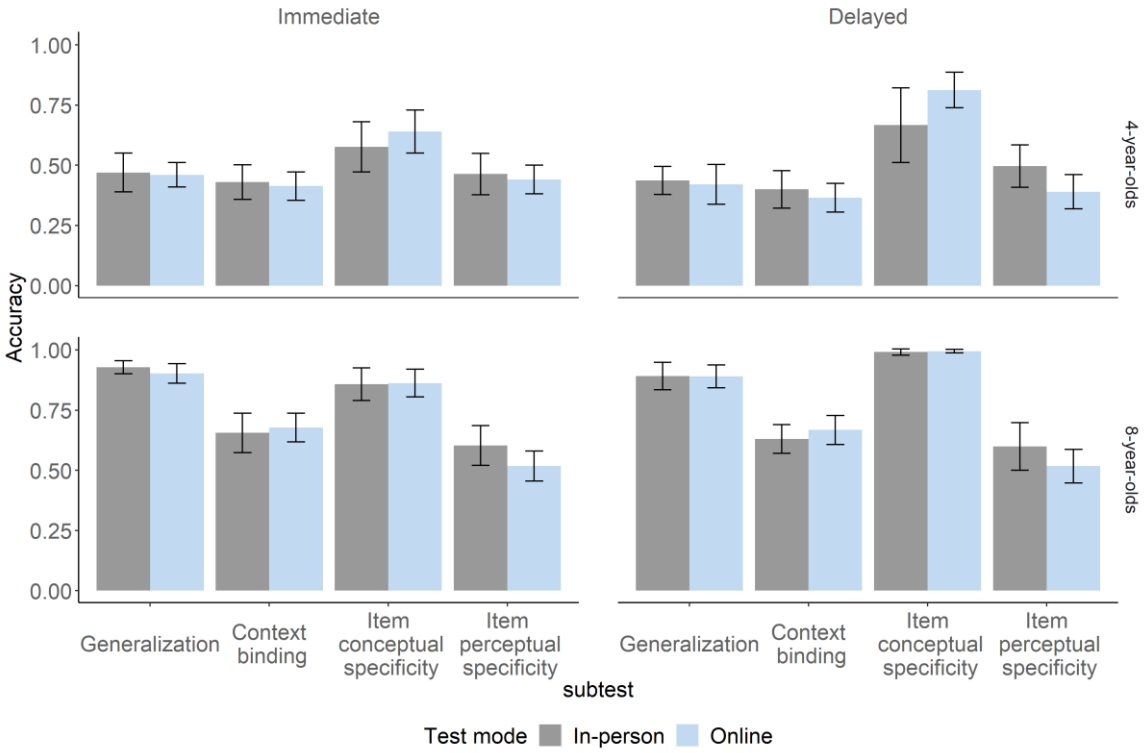
Note. R^2 = 0.02, F = 2.32 on 1.00 and 139.00 degrees of freedom, CI = confidence interval of beta, LL = lower limit of CI, UL = upper limit of CI. p_{adj} was corrected for multiple testing according to the Bonferroni method through multiplication by 3.

Supplementary Table 18

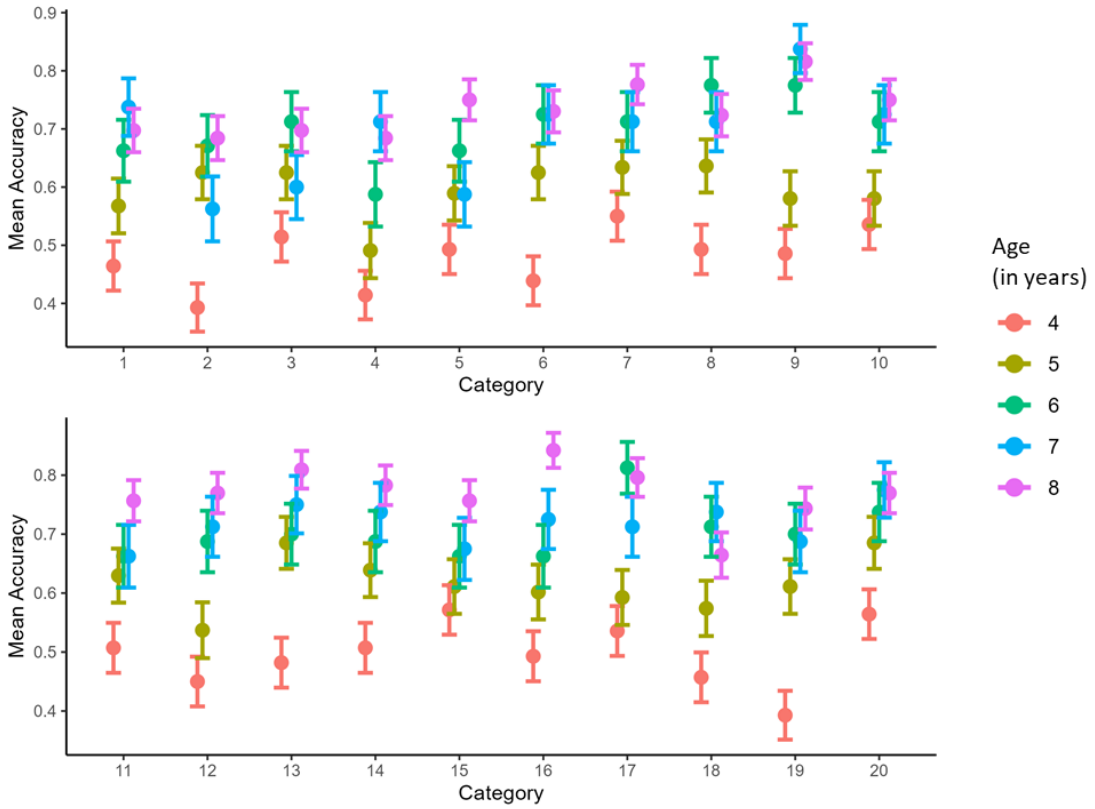
Effect of retention in context binding, item perceptual specificity and age (months) on gain in generalization performance

Predictor	$beta$	95% CI [LL, UL]	$t(119)$	p
Intercept	0.04	$[-0.13, 0.21]$	0.47	.642
Item perceptual specificity	0.10	$[-0.08, 0.27]$	1.11	.268
Context binding	0.03	$[-0.15, 0.21]$	0.32	.746
Age (months)	0.28	$[0.09, 0.47]$	2.86	.005

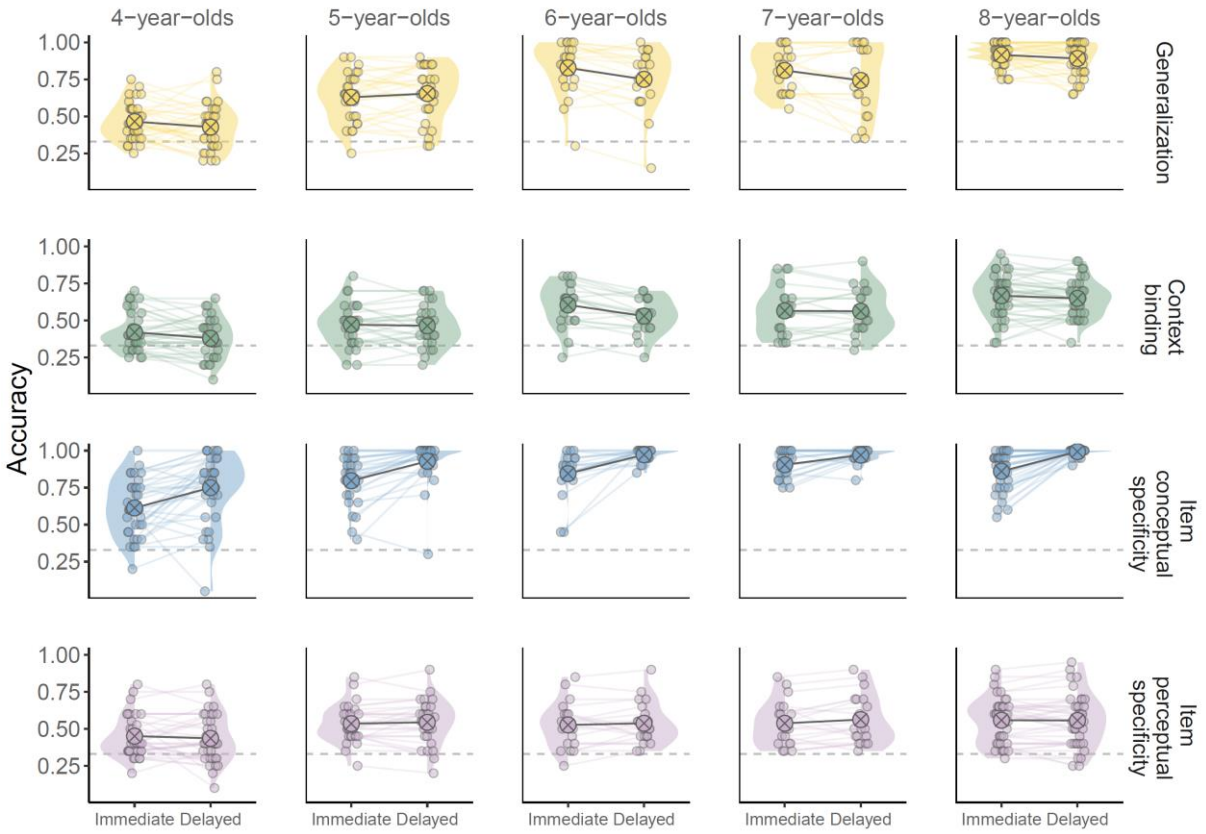
Note. $R^2 = 0.11$, $F = 5.12$ on 3.00 and 119.00 degrees of freedom CI = confidence interval of beta. LL = lower limit of CI, UL = upper limit of CI.



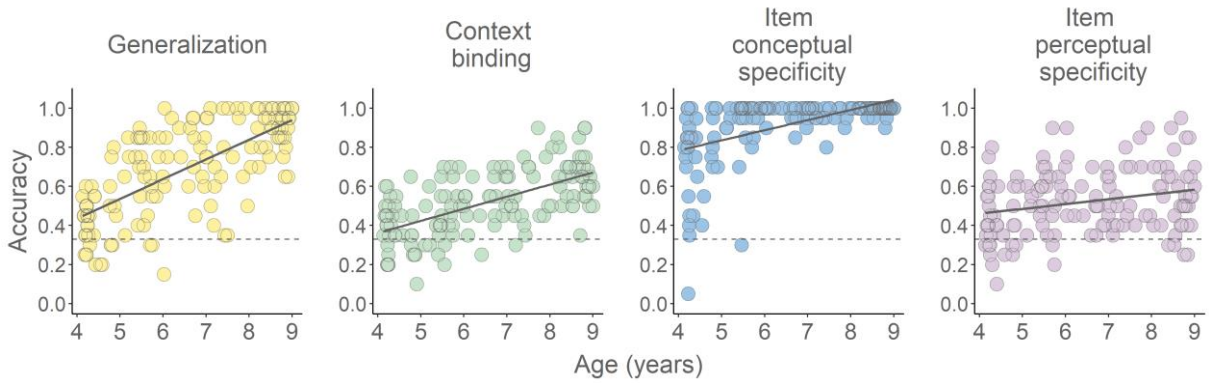
Supplementary Figure 1. Accuracy for in-person and online tested 4- and 8-year-olds. For pairwise comparisons between test modes refer to Supplementary Tables 2 and 3. Error bars reflect the 95% confidence interval.



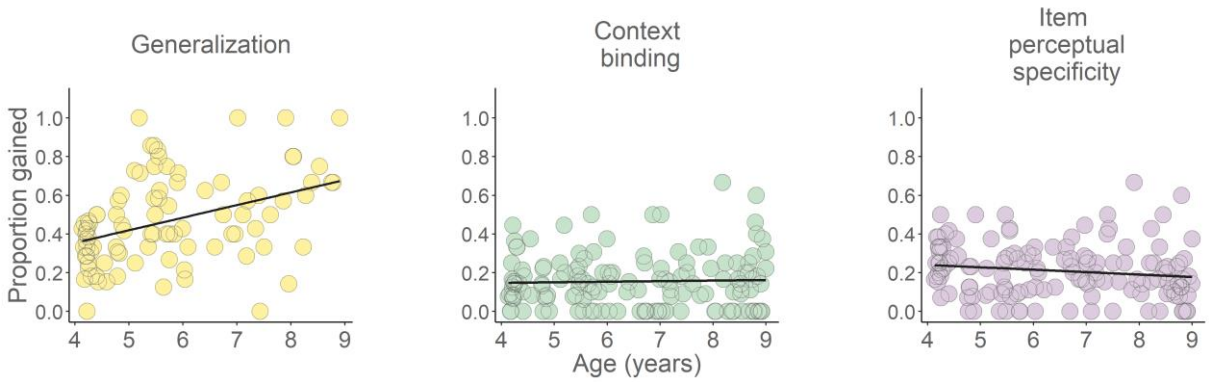
Supplementary Figure 2. Mean accuracy during Session 1 per category grouped by age in years, aggregated across subtask. The dots indicate group means, the errorbars indicate standard errors. Category numbers represent the following semantic categories: 1: art, 2: kitchen utensils, 3: medical items, 4: farm, 5: clothing, 6: furniture, 7: insects, 8:birds, 9:sport items, 10: vehicles, 11: funfair, 12:mammals, 13: underwater animals, 14: school, 15: construction, 16: halloween, 17: fruit, 18: instruments, 19:space, 20: candy



Supplementary Figure 3. Accuracy for immediate and delayed performance per subtest (rows) and age groups (columns). Individual points reflect the accuracy of each participant. The larger points represent the group mean.



Supplementary Figure 4. Association between age and delayed performance for each subtask. Chance level of 0.33 is indicated by the dashed lines. Each dot represents a participant. The solid lines show the best-fitting least squares regression association between memory accuracy (plotted on the y-axis) and participants' age (plotted on the x-axis).



***Supplementary Figure 5*.** Association between age and gained items for each subtask without ceiling trials. Each dot represents a participant. The solid lines show the best-fitting least squares regression association between proportion gained (plotted on the y-axis) and participants' age (plotted on the x-axis).