Learning with animation: The impact of cueing and sequencing of information on cognitive load, knowledge acquisition and attention

ABSTRACT

According to Cognitive Load Theory, visual cues and a sequenced presentation of information can foster learning in particular by reducing extraneous cognitive load due to, for example, avoiding unnecessary search processes through attention guidance. Especially when learning with volatile media such as videos or animations, reducing search processes are indispensable to gather as much relevant information as possible in a limited period. In this study, we experimentally investigated the effects of various types of cueing and sequencing in animations on learning performance, cognitive load, and attention. 215 participants aged 18-30 were randomly assigned to five groups. The animations differed in type of cueing and sequencing: without cueing and sequencing, with static cueing, with dynamic cueing, with sequencing, and with sequencing and cueing. Only dynamic cueing, sequenced cueing, and sequencing fostered performance, improved cognitive load, and increased attention; this suggest that only dynamic processing aids positively affect learning with volatile media.

THEORY

A sequenced and cued presentation of information in complex content can both foster knowledge acquisition and reduce cognitive load (Chandler & Sweller, 1991; Mayer, 2012; Schnotz & Lowe, 2008; van Gog, 2014). This can especially be explained by the signaling- and sequencing-principle of the Cognitive Load Theory (Chandler & Sweller, 1991) and the Cognitive Theory of Multimedia Learning (Mayer, 2012).

RESEARCH QUESTION

What impact do **static cueing**, **dynamic cueing**, **sequencing** and **sequenced cueing** of information have on **knowledge acquisition**, **cognitive load** and **attention**?

METHOD

Participants

215 people aged 18 to 30 (*mean* = 22,08; *SD* = 3,25; 124 female and 91 male), randomly assigned to a control group or one of four experimental groups

Design

Incomplete 3 x 2 design

		Cueing		
		No	Static	Dynamic
Sequencing	No	CG	EG_1	EG_2
	Yes	EG_3	EG_4	

Note. EG = experimental group, CG = control group

Procedure

Pre Intervention

Questionnaire

- demographics
- native language
- fear of flying
- divergence in color perception

Pre-Test

- multiple-choice-test
- labeling-pictures-task

Intervention

standardized Video

CG = video no cueing no sequencing

EG_1 = video static cueing no sequencing

EG_2 = video dynamic cueing no sequencing

EG_3 = video no cueing with sequencing

EG_4 = video sequenced cueing

Post Intervention

Post-Test

- multiple-choice-test
- labeling-picture-task

Questionnaire

- cognitive load
- attention

Features of the scales

Scales	Items	*M*	*SD*	*α*
KA Pre-Test	11	10,57	4,29	,65
KA Post-Test	11	23,51	3,72	,73
ICL	3	67,68	20,36	,90
ECL	6	19,91	16,86	,88
GCL	4	71,85	20,07	,90
Attention	5	71,89	25,23	,94

Note. *α* = Cronbach's *α*; KA = knowledge acquisition; ICL = intrinsic cognitive load; ECL = extraneous cognitive load; GCL = germane cognitive load; A = attention

RESULTS

A group comparison using a one-factor analysis of variance showed no significant differences with regard to age (p=,97) and prior knowledge (p=,86). One-factor analysis of variance with a-priori-contrasts confirmed that **dynamic cueing**, **sequenced cueing**, as well as **sequencing fostered knowledge acquisition**, **improved cognitive load**, and **increased attention**. Regarding knowledge acquisition static cueing did not outperform the control condition (p=,23).

Comparison of pre-post-test performance in knowledge test (knowledge acquisition)

Group	Item	*KA in %*	Pre-Test *M*	Pre-Test *SD*	Post-Test *M*	Post-Test *SD*	*t*(214)	*p*	95% CI *LL*	95% CI *UL*	*d*
EG_4	RET	127.15	5.12	2.43	11.63	0.62	15.37	<.001	5.66	7.37	3.67
(*n*=41)	COM	128.06	3.10	1.45	7.07	0.76	16.18	<.001	3.48	4.47	3.43
	LP	233.89	2.39	1.77	7.98	0.16	19.84	<.001	5.02	6.15	4.45
EG_3	RET	105.74	5.40	2.22	11.11	1.34	17.05	<.001	5.03	6.38	3.11
(*n*=47)	COM	124.19	2.77	1.48	6.21	1.28	11.70	<.001	2.85	4.04	2.49
	LP	295.08	1.83	1.83	7.23	1.13	16.97	<.001	4.76	6.05	3.58
EG_2	RET	104.93	5.48	2.01	11.23	0.95	20.30	<.001	5.18	6.32	3.66
(*n*=48)	COM	97.81	3.19	1.42	6.31	1.15	12.15	<.001	2.61	3.64	2.42
	LP	205.63	2.31	1.84	7.06	1.33	14.41	<.001	4.09	5.41	2.96
EG_1	RET	76.90	5.67	2.41	10.03	1.94	9.97	<.001	3.47	5.26	1.99
(*n*=33)	COM	61.59	3.15	1.40	5.09	1.51	6.01	<.001	1.28	2.60	1.33
	LP	253.76	1.73	1.66	6.12	1.39	12.93	<.001	3.70	5.09	2.87
CG	RET	84.54	5.11	2.19	9.43	1.46	13.27	<.001	3.67	4.98	2.32
(*n*=46)	COM	33.24	3.46	1.44	4.61	1.64	3.64	.001	0.51	1.15	0.75
	LP	182.33	2.15	1.93	6.07	1.31	11.85	<.001	3.25	4.58	2.38

Note. EG = experimental group; CG = control group; RET = retention; COM = comprehension; LP = labeling picture; KA = knowledge acquisition; CI = confidence interval; LL = lower limit; UL = upper limit; *d*=Cohen's d

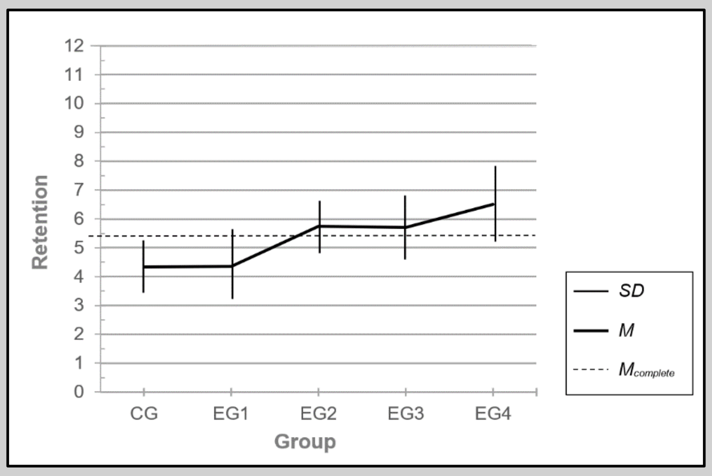

Figure 1. Scores of retention in a comparison of differences in pre-post-test results

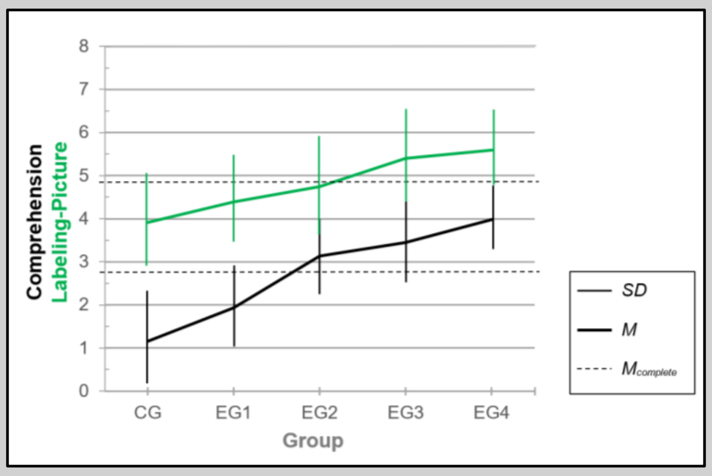

Figure 2. Scores of comprehension and labeling-pictures in a comparison of differences in pre-post-test results

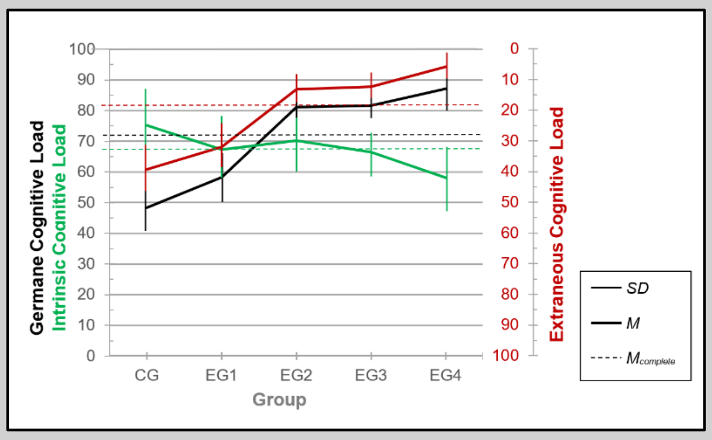

Figure 3. Perceived cognitive load during the video session

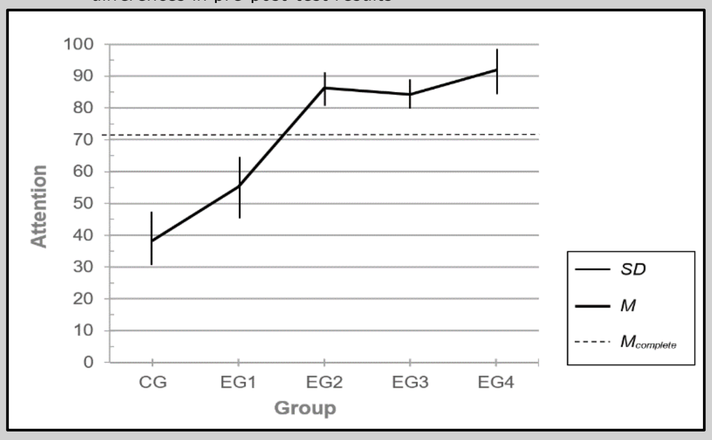

Figure 4. Attention during the video session

DISCUSSION

The findings indicate that in learning with complex content especially **dynamic presentation styles** had a **positive effect** on knowledge acquisition, cognitive load, and attention, even if there is no cueing. Susceptibly in case of complex content, the decision for a dynamic presentation and against a static one makes sense.

REFERENCES

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. Cognition and instruction, 8(4), 293-332.

Mayer, R. E. (2012). Multimedia Learning. Cambridge: Cambridge University Press.

Schnotz, W., & Lowe, R. (2008). A unified view of learning from animated and static graphics. In R. Lowe & W. Schnotz (Eds.), Learning with animation: Research implications for design (pp. 304-356). Cambridge: Cambridge University Press.

van Gog, T. (2014). The signaling (or cueing) principle in multimedia learning. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 263-278). New York: Cambridge University Press.

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