Children's attention management on commercial websites: Effects of task type and advert prominence

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Children and the commercial web

- **children use commercial sites**
- gaming, social networks
- informations search
- reading-for-comprehension
- sophisticated advertising

- **cognitive development 9yrs**
- task-oriented interaction
- task performance
- executive functions
- advert distraction
- cognitive load

Holmberg, N., Sandberg, H., & Holmqvist, K. (2014). Advert saliency distracts children's visual attention during task-oriented internet use. *Frontiers in psychology*, *5*.

Cognitive load theory

- **intrinsic load:** inherent level of difficulty associated with different task types, e.g. visual search

- **extraneous load:** usability of visual interfaces depending on design, e.g. advert saliency

- **limited capacity:** tasks with high intrinsic load limit resources available to process distractors

Lang, A. (2000). The limited capacity model of mediated message processing. *Journal of communication*, *50*(1), 46-70.

Children's attention management

- **advert distraction**
- fixations:
  overt, voluntary attention
- advert prominence:
  static, animated
- more prominent, more fixations
- level of executive control

- **cognitive load**
- intrinsic load: task types
- extrinsic load: advert prominence
- interaction effects?
- executive control
- limited capacity

Holmberg, N., Sandberg, H., & Holmqvist, K. (2014). Advert saliency distracts children's visual attention during task-oriented internet use. *Frontiers in psychology*, *5*.

Task types and cognitive load

- task-evoked pupillary response, task types requiring high levels of cognitive load are associated with increased pupil size

- **reading-for-comprehension high intrinsic cognitive load?**
- **visual search low intrinsic cognitive load?**

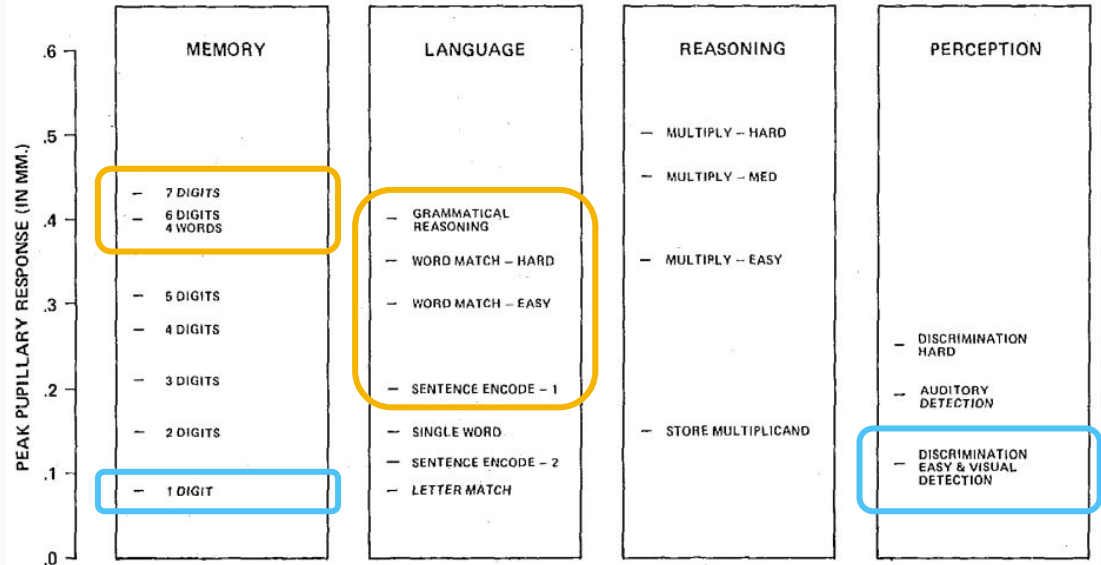- **advert saliency:** effects of extraneous cognitive load?

Figure 8. Peak amplitudes of the task-evoked pupillary responses obtained in a range of qualitatively different cognitive tasks, arranged by type of task. (The pupillary response provides a reasonable ordering of tasks on the basis of presumed processing load. See text for further details.)

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational psychologist*, *38*(1), 63-71.

Beatty, J. (1982). Task-evoked pupillary responses, processing load, and the structure of processing resources. *Psychological bulletin*, *91*(2), 276.

Hypotheses - advert distraction, cognitive load

- **H1a:** animated adverts will be associated with higher levels of advert distraction (fixations) than static adverts.

- **H1b:** animated adverts will be associated with higher levels of extraneous cognitive load (pupil size) than static adverts.

- **H2a:** reading tasks will be associated with lower levels of advert distraction (fixations) than visual search tasks.

- **H2b:** reading tasks will be associated with higher levels of intrinsic cognitive load (pupil size) than visual search tasks.

Methods
- data collection

- **participants**
  - 57 children
  - 3rd grade (9-10 yrs)
  - school environment

- **recording apparatus**
  - smi redm, 120 Hz
  - experiment center
  - ie11 web browser

- **procedure**
  - anti-saccades
  - web experiment
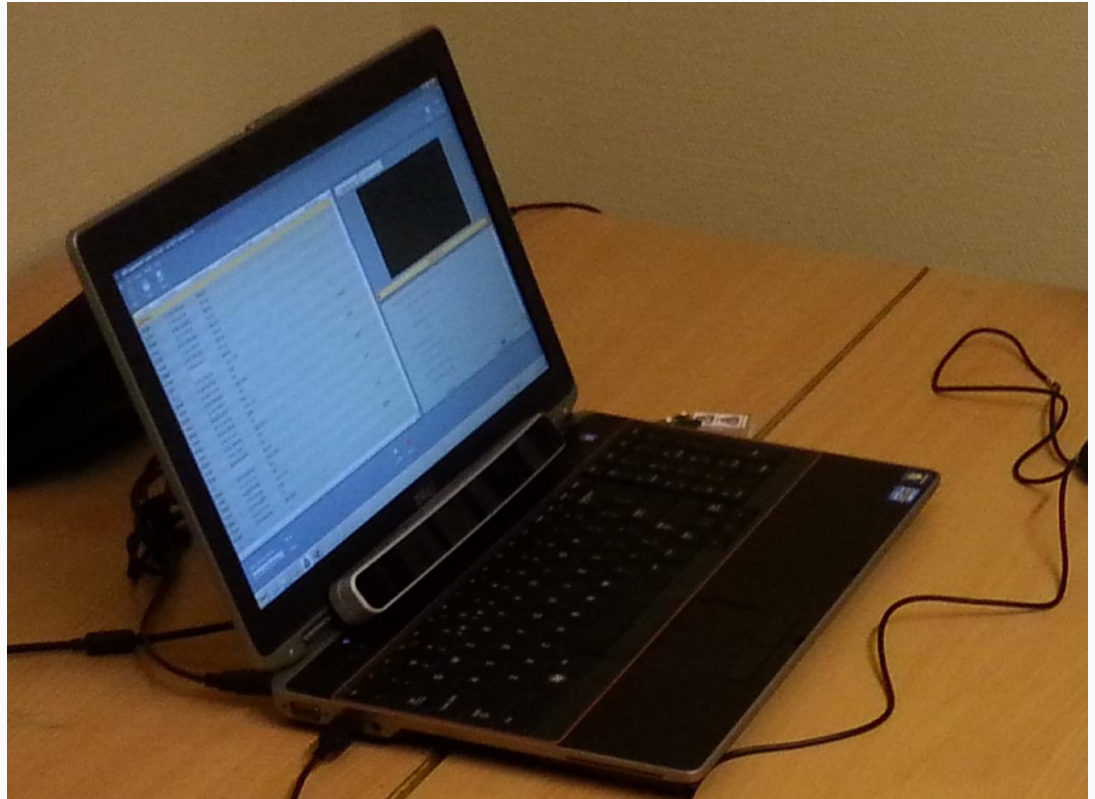
Methods
- study design

- **web page stimuli**
  - mockup news site
  - 6 IReST texts
  - 6 concurrent adverts
  - 2 x 2 conditions

- **2 task types** (fixed order)
  - intrinsic load
  - reading-for-comp (high)
  - visual search (low)

- **2 advert saliency** (randomized)
  - extraneous load
  - animated (high)
  - static (low)

1. reading for comprehension, max 90 seconds, questions

2. distraction task, max 60 seconds

3. visual search, find word and click on it, max 30 seconds

Methods
- data analysis

- **event detection**, aoi analysis, aggregated over trials

- **dependent measures**
    - cognitive load, average pupil dilation in fixations on task aoi
    - advert distraction, mean number of fixations per minute on advert aoi

- **within-subjects**, same participants measured across task types and advert saliency conditions

Results
- task performance

- **task types:** reading, search
  - **max duration:** 90, 30 sec

- **performance measures**
  - **task accuracy:** reading comprehension, search success
  - **task duration:** time spent

- **advert prominence:** static, animated

- **significant decrease in reading comprehension due to animated adverts**

task types

performance

	Reading, task accuracy (binomial)			Search, task accuracy (binomial)		
	Mean	SD	SE	Mean	SD	SE
Static	0.501	0.500	0.022	0.556	0.498	0.038
Animation	0.437	0.496	0.022	0.526	0.501	0.038

	Reading, task duration (90 seconds max)			Search, task duration (30 seconds max)		
	Mean	SD	SE	Mean	SD	SE
Static	74.90	16.64	1.27	23.42	7.62	0.58
Animation	74.23	17.66	1.35	23.37	7.94	0.61

Results
- advert distraction

- **advert prominence:** animated adverts associated with more advert fixations per minute **(H1a)**

- **task types:** reading-for-comp. associated with less advert fixations per minute ~~(H2a)~~

- **interaction:** no effect, independent factors

mean number of advert fixations by task type and advert prominence
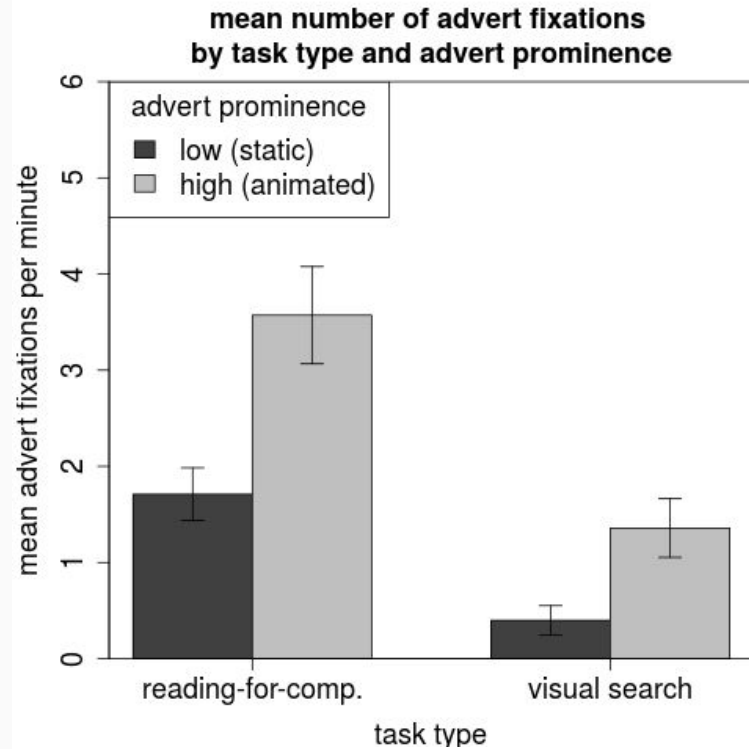
Predictors	Estimate	Std. Error	t value	p value
(Intercept)	2.177	0.690	3.154	0.002
Task type (visual search)	-1.311	0.395	-3.320	0.001
Advert prominence (animation)	1.861	0.527	3.533	0.000
Gaze control (anti-saccades)	-1.335	1.572	-0.849	0.396
Interaction				
Task type × Advert prominence	-0.902	0.585	-1.542	0.123

Conclusions
- advert prominence, extraneous load

- EXTRANEOUS LOAD

- **advert prominence: static**
- less advert distraction (H1a) ✅
- less cognitive load (H1b)

- **advert prominence: animated**
- more advert distraction (H1a) ✅
- more cognitive load (H1b)
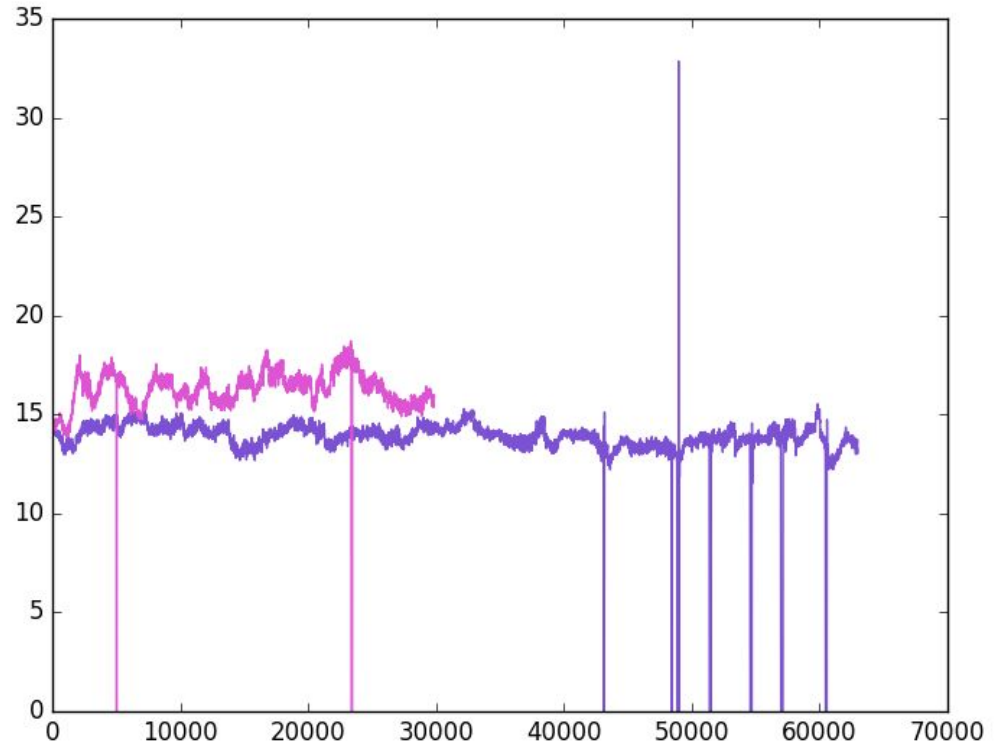
- INTRINSIC LOAD

- **task type: reading**
- more advert distraction (H2a) ❌
- less cognitive load (H2b)

- **task type: search**
- less advert distraction (H2a) ❌
- more cognitive load (H2b)

Cognitive load - pupil size

- **pupil size:** horizontal diameter in pixels, mitigate blinks, controlled stimuli, same luminance

- **visual search**
  - max 30 seconds

- **reading-for-comp.**
  - max 90 seconds

- **possible confounds:** distance to screen, visual search tasks more exciting, engaging (time limit), positive emotion, valence

Results
- cognitive load

- **advert saliency:** animated adverts associated with larger average pupil size, extraneous cognitive load **(H1b)**

- **task types:** visual search associated with larger average pupil size, higher levels of intrinsic cognitive load ~~(H2b)~~

- **interaction:** no effect, independent factors

mean pupil dilation by task type and advert prominence
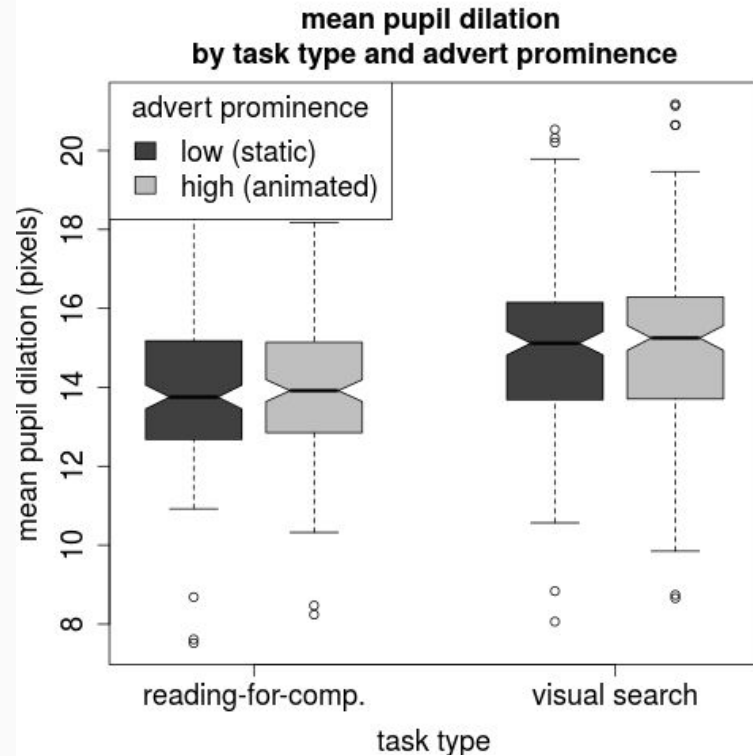
Predictors	Estimate	Std. Error	t value	p value
(Intercept)	14.678	0.525	27.939	0.000
Task type (visual search)	1.149	0.090	12.835	0.000
Advert prominence (animation)	0.181	0.072	2.520	0.012
Gaze control (anti-saccades)	-2.222	1.334	-1.665	0.096
Interaction				
Task type × Advert prominence	-0.119	0.099	-1.199	0.231

Conclusions
- advert prominence, extraneous load

- EXTRANEOUS LOAD

- **advert prominence: static**
  - less advert distraction (H1a) ✅
  - less cognitive load (H1b) ✅

- **advert prominence: animated**
  - more advert distraction (H1a) ✅
  - more cognitive load (H1b) ✅

- INTRINSIC LOAD

- **task type: reading**
  - more advert distraction (H2a) ❌
  - less cognitive load (H2b) ❌

- **task type: search**
  - less advert distraction (H2a) ❌
  - more cognitive load (H2b) ❌

Thanks!

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Discussion
- future research

- **supports:** previous saliency research, advert animation => more visual attention

- **supports:** limited capacity models: high intrinsic task load => low advert processing

- **needed:** updated taxonomy of task types and cognitive load: reading associated with less pupil dilation than search

- **needed:** examine instantaneous load over time, no effect of gaze control
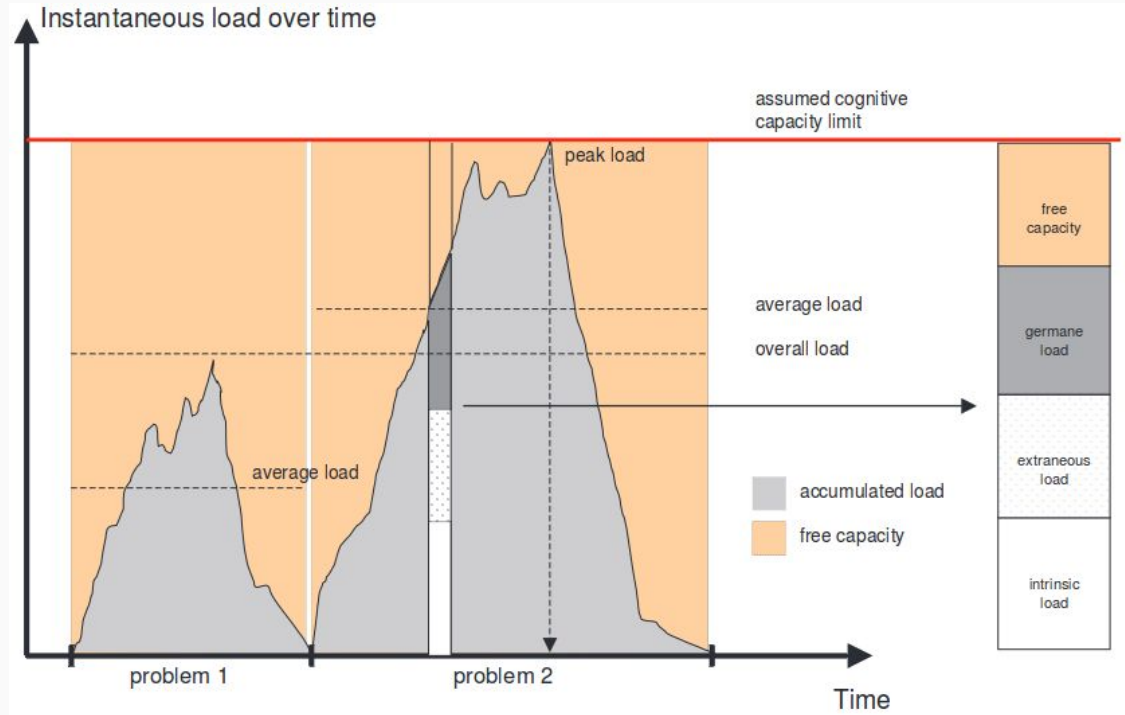
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Task type and visual attention to distractors

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Background - children, internet

- **children's internet use**
  - commercial websites
  - online gaming

- **cognitive development**
  - task-oriented interaction
  - 9 yrs, school work
  - information search

- **advert distraction**
  - task types
  - advert salience
  - cognitive load
  - task performance

Mean frequency of online activity by age group
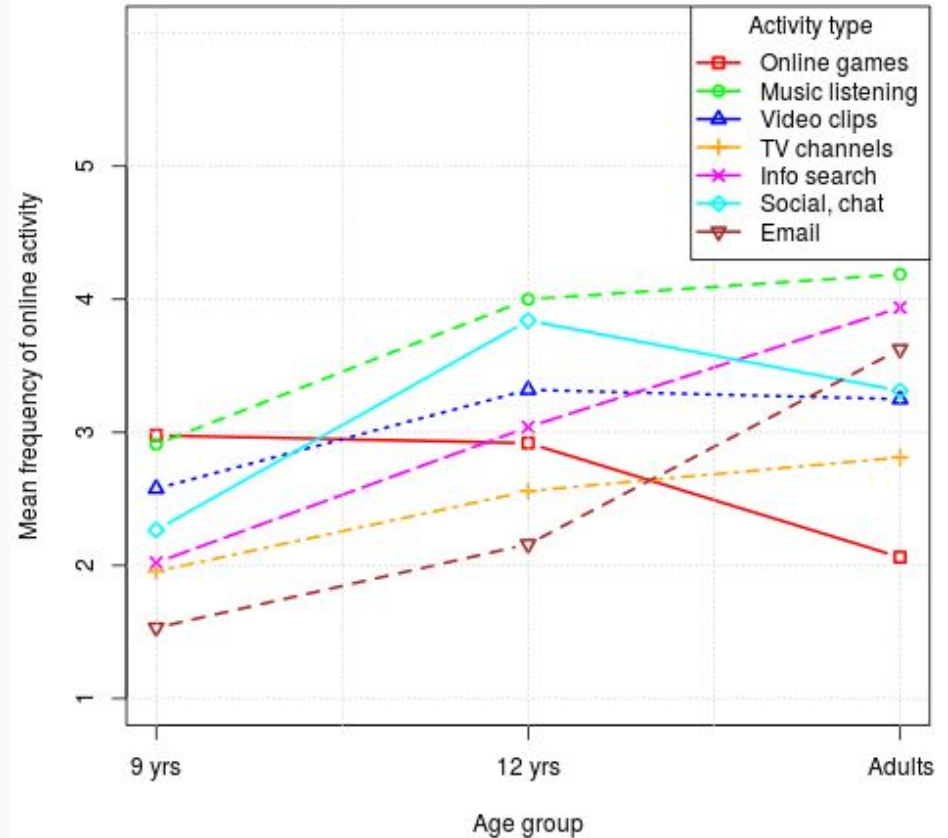
Background
- advert distraction

- **advert saliency conditions**
- animation, abrupt onset
  - increases advert attention
  - disrupts reading comprehension
- content relevance
  - more saccades, fixations on adverts

- **gaze control**
  - moderating effect

- **task types**
  - cognitive load
  - saliency conditions

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Hypotheses
- cognitive load, advert distraction

- **H1a:** reading tasks will be associated with higher levels of intrinsic cognitive load (pupil size) than visual search tasks.

- **H1b:** reading tasks will be associated with lower levels of advert distraction (fixations) than visual search tasks.

- **H2a:** animated adverts will be associated with higher levels of extraneous cognitive load (pupil size) than static adverts.

- **H2b:** animated adverts will be associated with higher levels of advert distraction (fixations) than static adverts.

- **H3a:** higher levels of gaze control in children will be associated with lower levels of cognitive load (pupils size).

- **H3b:** higher levels of gaze control in children will be associated with lower levels of advert distraction (fixations).

1. reading for comprehension,
max 90 seconds, questions

2. distraction task,
max 60 seconds

3. information search, find word
and click, max 30 seconds

Hypotheses
- cognitive load, advert distraction

- **H1a:** reading tasks will be associated with higher levels of cognitive load (pupil size) than visual search tasks.

- **H1b:** animated adverts will be associated with higher levels of cognitive load (pupil size) than static adverts.

- **H1c:** higher levels of gaze control in children will be associated with lower levels of cognitive load (pupils size).

- **H2a:** reading tasks will be associated with lower levels of advert distraction (fixations) than visual search tasks.

- **H2b:** animated adverts will be associated with higher levels of advert distraction (fixations) than static adverts.

- **H2c:** higher levels of gaze control in children will be associated with lower levels of advert distraction (fixations).

Hypotheses

- H1a: task types with high intrinsic load (reading) will cause more visual attention to task than tasks with low load (search)

- H1b: task types with high levels of intrinsic cognitive load (reading) will be associated with less visual attention to adverts

- H1c: high levels of gaze control will be associated with more visual attention to task

- H2a: adverts with high extraneous load (animation) will be associated with less visual attention to task

- H2b: adverts with high extraneous load (animation) will be associated with more visual attention to adverts

- H2c: high levels of gaze control will be associated with less visual attention to adverts

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buskarna eftersom de hamnat i skuggan från bladverket. På detta vis
uppstår nya skogar med tiden. Många träd växer väldigt långsamt och
några har en väldigt lång livslängd. När gamla träd dör växer det fram
yngre träd i dess ställen. Skogar är levande platser som kan förbli
oförändrade under långa perioder, vilka träd som kan hittas i en skog
beror på omgivningens klimat.

Klicka här när du är klar!

high cognitive load = high perceptual load?

implications: new research design to investigate children's cognitive load and advert distraction during reading on commercial websites

implications: limit advert saliency on children's websites that involve reading