Extrapolating significance of text-based autonomous vehicle scenarios to multimedia scenarios and implications for user-centered design

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Introduction

- Importance of contextual emotion effects

- Extrapolation from design Iterations using multiple perspectives (Norman & Verganti 2014)

- Contribution: (I) a proposal for greater *extrapolation robustness* and (II) replication of cognitive elaboration emotional effect
    - → We suggest extrapolation from paired experiments containing multiple perspectives as a "stress test" that implies significance from lower to higher experimental fidelity (e.g. from text to text-image) from additional evidence.

Introduction
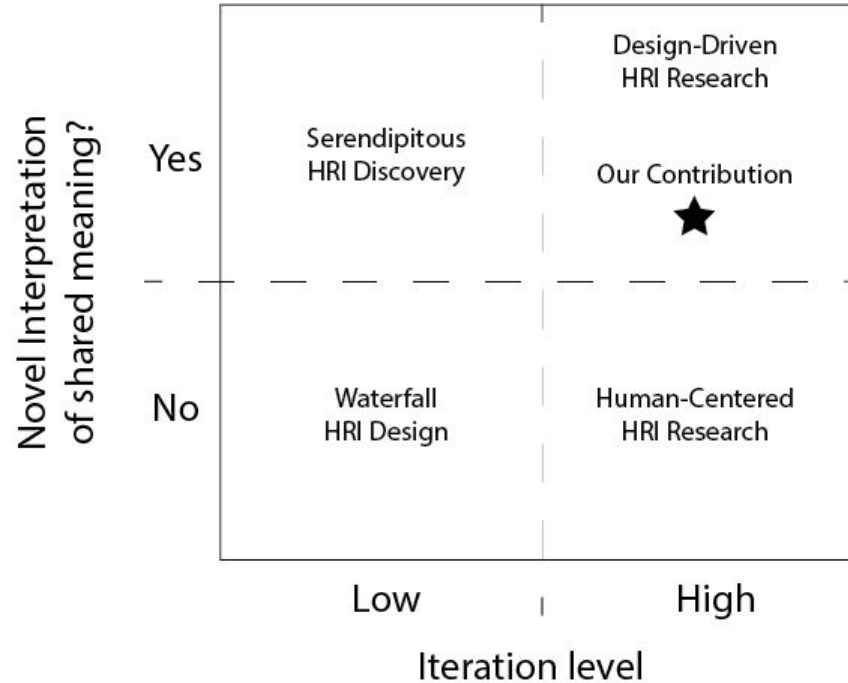
(figure adapted from (Norman & Verganti 2014)

Introduction: testing contextual AV emotion effects

Cognitive Elaboration

Emotional and Vivid
AV Vignette → Change in Valence
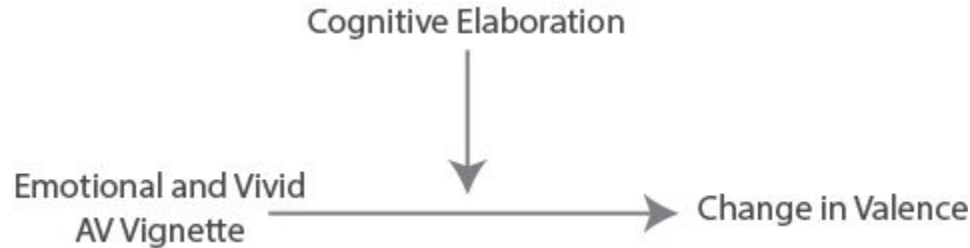
1. Known that in positive emotional vivid scenarios that high levels of **cognitive elaboration** *moderate* **emotion** (Blonde & Girandola 2014); by being associated with greater positive change.
2. Because AVs and HRI often elicit mixed feelings it is unknown if cognitive elaboration acts similarly. To investigate, we test the above theoretical model in text-based AV emotional scenarios (or *vignettes*). We create **low** and **high cognitive elaboration** levels by **single** and **multi-authorship** of positive and negative scenarios. Scenario content is controlled for critical keywords, overall theme and length. (more detail in Method)

Hypothesis 1: That multi-authored vignettes will cause more positive emotion induction than single authored scenarios

Introduction: extrapolation from paired experiments

- Our basis for extrapolation starts with a view of HRI experimental subjects as *learners in a multimedia experiment*; because "even as experimental HRI subjects, humans continuously learn from experiences."

- The relationship between learners and multimedia are theorized in the *cognitive theory of multimedia learning* (MLT) (Mayer 2014) and predict when learning will and will not occur.

- As a basis for extrapolation MLT theory is useful because **when learning will not occur**, due to *cognitive overload*, then most **experimental effects also do not occur**. "Under multimedia learning theory, **an HRI experiment contains *germane*, *extraneous* and *intrinsic* mental loads (or *cognitive demands*) in relation to the dependent variable of interest.**"

Introduction: extrapolation from design Iterations

		Experimental Media Type(s)				
		Text		Text+Image		
		Cognitive Elaboration Level				
		Low	High	Low	High	
Load Type	intrinsic	0	0	+	+	
	extraneous	0	+	0	+	
	germane	0	+	0	+	
	significance	Y	Y	Y	?	(Case 1)
		N	Y	?	?	(Case 2)
		N	N	N	?	(Case 3)

Case 1: exp. signf. at both cog. elab. levels → likely also signf. for higher fidelity at low cog. elab.

Case 2: exp. signf. at one cog elab level → mixed outcomes for higher fidelity at low cog elab

Case 3: no exp. signf. → no signf. for higher fidelity or medium related biases unaccounted

Method: High Cognitive Elaboration

- Theoretical basis for creating higher levels:
	(a) Exposure to different driving attitudes than held by the reader;
	(b) alternative choice of semantics and syntax

Collect different driving attitudes, semantics and syntax through a crowdsourced task where other authors rewrite the original text-based AV scenarios using a constrained UI.

- We control responses for theme, critical keywords and length

Survey Completion
0% ━━━ 100%

Scenario Environment: Highway

Emotional theme: Happy/Excited

Driving Part Revision Instructions

- Revise to get word count to 0 or slightly less
- Must include the following key words: "bright", "spring", "computer", "hour", "shorter"
- Must be written in first person ("I" point of view)
- During Car Handoff part the car asks the driver to take over

⚠ Your response must be at least 700 characters.

Original Driving Part:

The worker enthusiastically asks if you work for the startup and you both say yes at once. He describes how your company research saved someone close to him a couple of months ago and waves you through to the open lane with a construction placard!

The car navigates into the open lane and as you pick up speed you can't believe your luck. The mapping feature now indicates a much shorter twenty minute arrival time!

**Revised Driving Part**
word count: 292
key words left to include: hour,spring,computer

A bright example of a shorter scenario

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Method: Experimental design, Test of Hyp. 1

- **Independent variable**
  - Cognitive elaboration level (high/low)
- **Quasi-independent variable**
  - Prevailing level of vividness (measured post experiment, uncontrolled)
- **Dependent variable**
  - Change in valence as pretest-posttest
- **Task**: Read scenario outloud
- **Measure**: pretest-posttest valence self-report rating
- Randomized trials of positive (2) and negative (2) text-based AV scenarios

Hypothesis 1: That multi-authored vignettes will cause more positive emotion induction than single authored scenarios
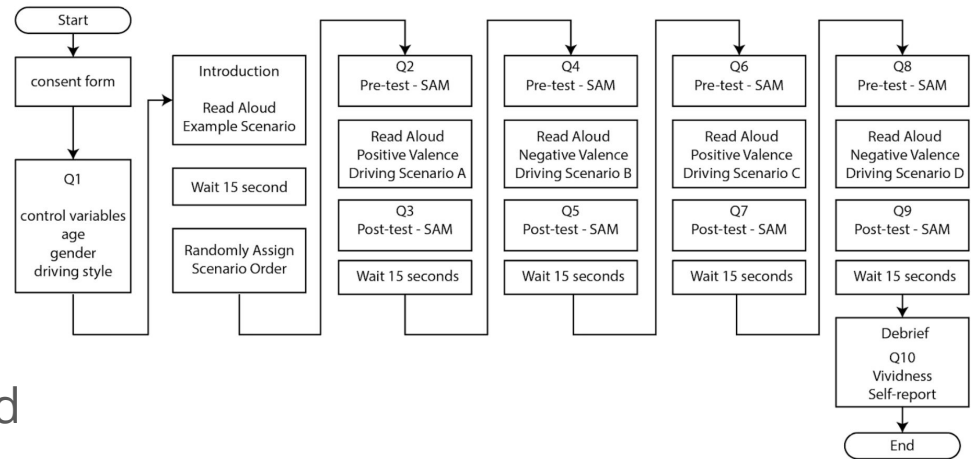
Method: Tasks

- Pretest and posttest valence rating using self-assessment manikin (Bradley & Lang 1994)
- Read aloud given AV scenario

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Results

What: count distribution of three emotional induction outcomes: negative (-), no change (0) and positive (+) on cog. elab. condition.

1. In the **negative** emotion AV scenario **both** single and multi-authorship **significantly induced** negative valence. Figure not shown.

2. In the **positive** emotion scenario AV condition **multi-authorship** (blue) significantly **induced** positive valence. But single authorship (pink) did not. Figure of distributional shifts shown →

✓ **Hypothesis 1**

Count of positive, negative and none emotional valence changes for positive vingettes varying by authorship type (single, multi)

multi vs. single WSR, p < 0.01 ***, Z=16.03

type
single
multi

multi WSR, p = 0.01**, Z=-2.23

single WSR, p = 0.12, Z=-1.17

negative (-), no change (-) or positive (+) sign of induced valence
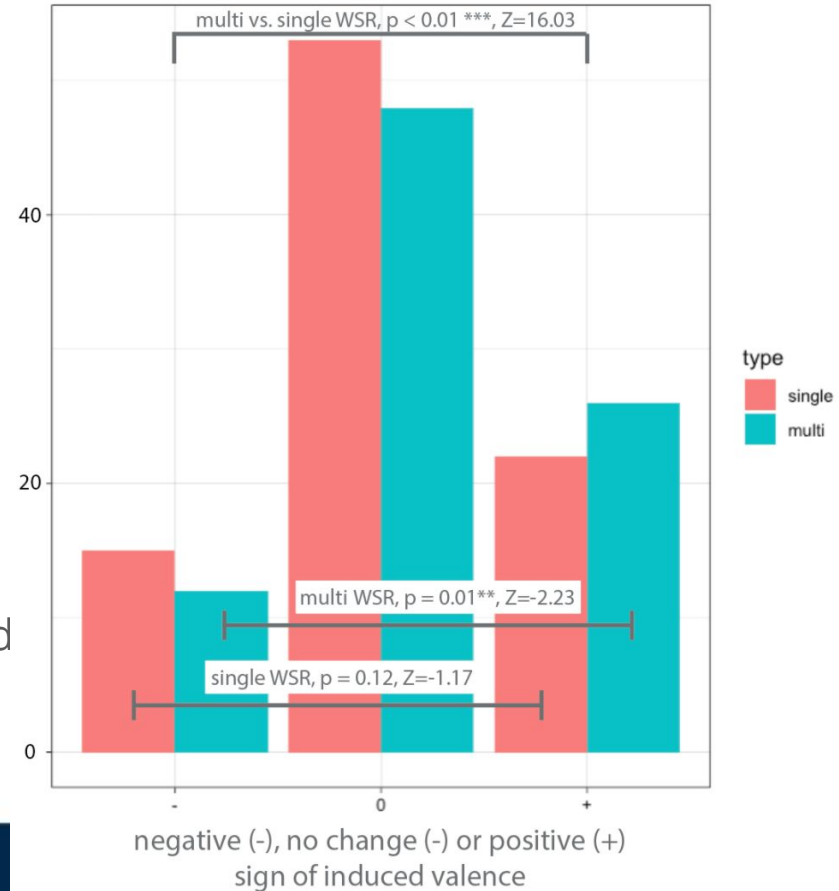
Discussion

- **In positive text-based AV scenarios, cognitive elaboration is associated with significant positive valence changes despite AV use being contentious in many ways. Replicates findings in psychology.**

- **Extrapolation proposal**
  - Significance at higher fidelity, no significance at lower fidelity → **Case 2: extrapolation to mixed results at higher fidelity**.

  - Supported by a post-hoc review of higher fidelity automated and manual driving experiments: where positive induction appears less robust than negative induction (Du 2020; Jeon 2014; Alyuz 2018). Furthermore, (Siedlecka 2019) finds emotion induction for general scenario based methods are more robust in negative than positive cases.

- **Future work**: control for vividness, isolate value of multiple perspective by comparing against single authored *revised* vignettes, directly test extrapolation proposal across higher fidelity medium to confirm accuracy and consider other dependent variables

Thank you!

Questions? Email kwamepr@umich.edu

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