Cognitive Discourse Analysis for cognitively supportive visualisations

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Motivation

- How do we know what people perceive in a diagram, picture, or dynamic visual interface?
- What users take from a visualisation may not be the same as what designers intended by it

"What are
you thinking?"

What can we learn from language use about thought?

Cognitive biases in visualisations

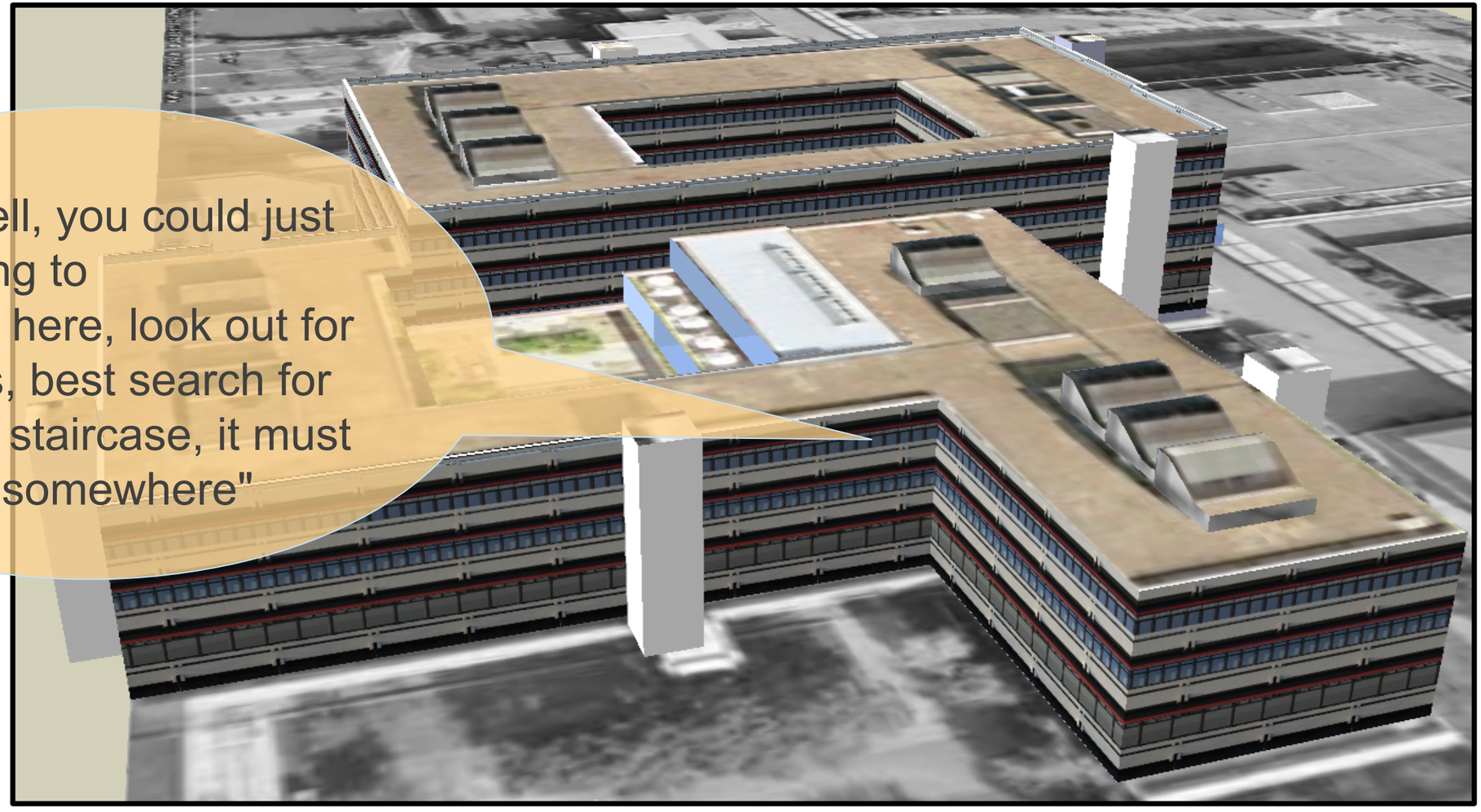
- How to find out what people are ‘reading into diagrams’ or other visualisations?
- Ask them (to put their interpretation into words)
  - Interpretation is, to some extent at least, a consciously accessible high level process
  - So some of this can be verbalised
  - But: Not all aspects will be verbalised

Cognitive biases in visualisations

- Suggestion:
  Take a closer look at HOW people verbalise – beyond WHAT they say
  - Language reveals more about thought than speakers realise

→ Cognitive Discourse Analysis

Excuse me, where is the Cafeteria?

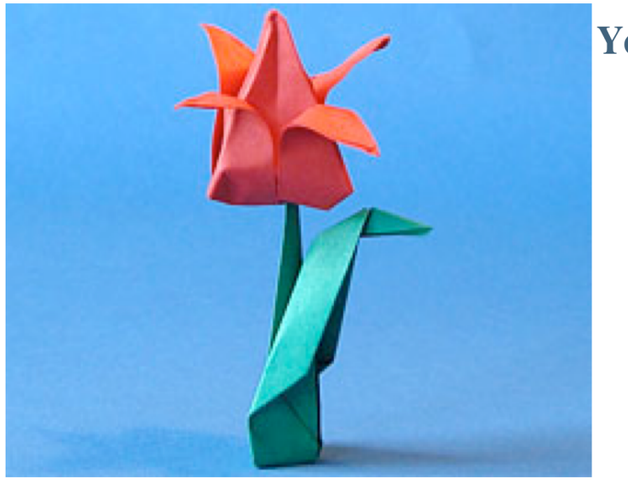


Cognitive Discourse Analysis for analysis of cognitive biases in visualisations

- Systematic patterns in speakers' linguistic and conceptual choices are addressed by
  - collecting freely produced data by sets of speakers in controlled situations
  - relating features of language to features of the (cognitive & communicative) situation
  - controlled experimental variation
  - triangulation with other kinds of data

How do people interpret Origami instructions?

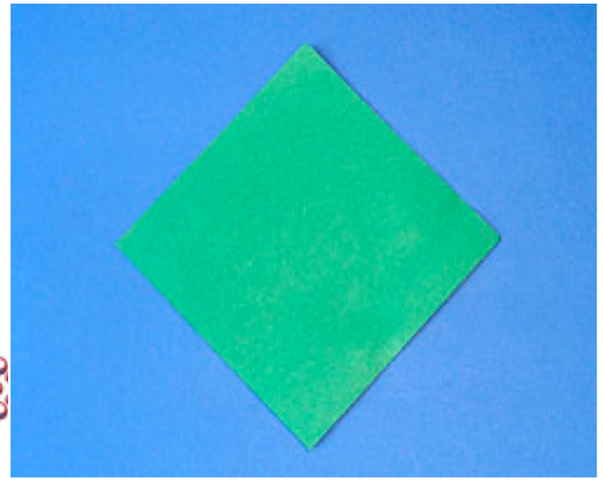
This is how you can make the stem



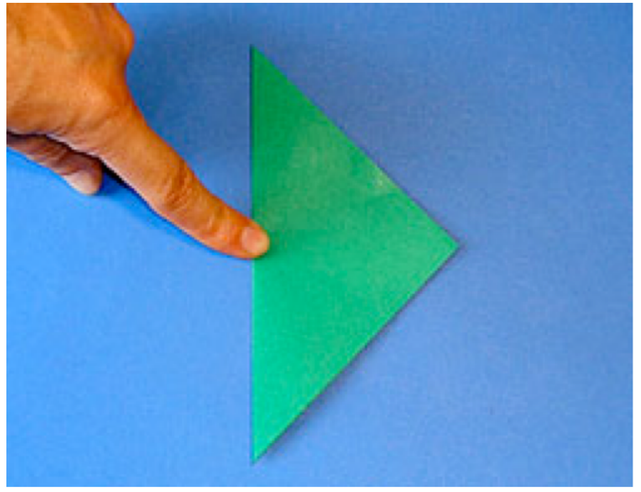
You'll need:

- Square green paper

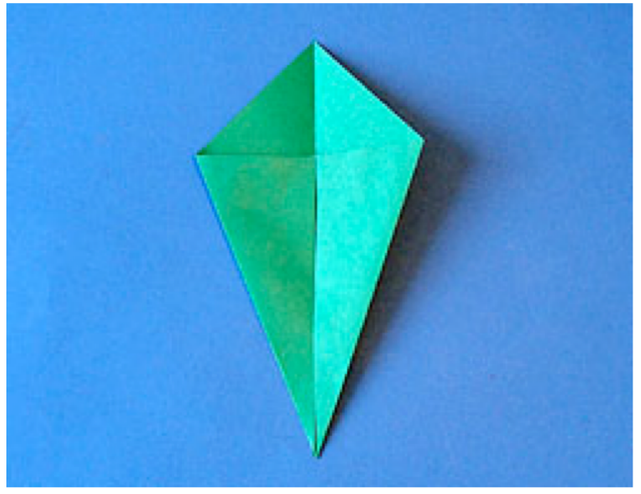
Instructions for the stem



- Put the paper in front of you, with one corner pointing towards you.



- Fold the left corner over to the right one, and firmly straighten out the fold.



- Open the paper again.
- Fold the bottom edges toward the midline.

How do people interpret Origami instructions?

Origami

- Study conducted with Holly Taylor, Tufts University, Medford (Boston, US)

- Tenbrink, Thora and Holly A. Taylor (in press). Conceptual transformation and cognitive processes in Origami paper folding. *Journal of Problem Solving*.

Main research question

To what extent

and in what ways

do speakers add their own ideas to given descriptions?

- This reflects the speaker's individual re-conceptualisation of the given content

Participants

- Twenty-four Tufts University undergraduates
- Native (American) English speakers
- Most had some previous experience with Origami paper folding

Procedure

- Participants were trained to think aloud
- Origami paper folding task
  - First stem, then blossom
- Crease matching task
- Three spatial ability tests
  - (of no further concern here)

Language data: Example

Alright
so put the paper in front of you with one corner pointing towards me.
I'm doing that.
next thing I need to fold the left corner over to the right one.
so I'm folding that so it's lined up and then straightening out the fold.
so it's telling me to open the paper again
so I do that and fold the bottom edges towards the midline.
so I guess that means fold this part to the center here.
and I'm trying to do that so it's as even as possible.
now I gotta do it with the other side and crease that part there

Annotation example

Reading instruction & something new

Task communication

Alright

so put the paper in front of you with one corner pointing towards me.

I'm doing that.

next thing I need to fold the left corner over to the right one.

so I'm folding that so it's lined up and then straightening out the fold.

so it's telling me to open the paper again

so I do that and fold the bottom edges towards the midline.

so I guess that means fold this part to the center here.

and I'm trying to do that so it's as even as possible.

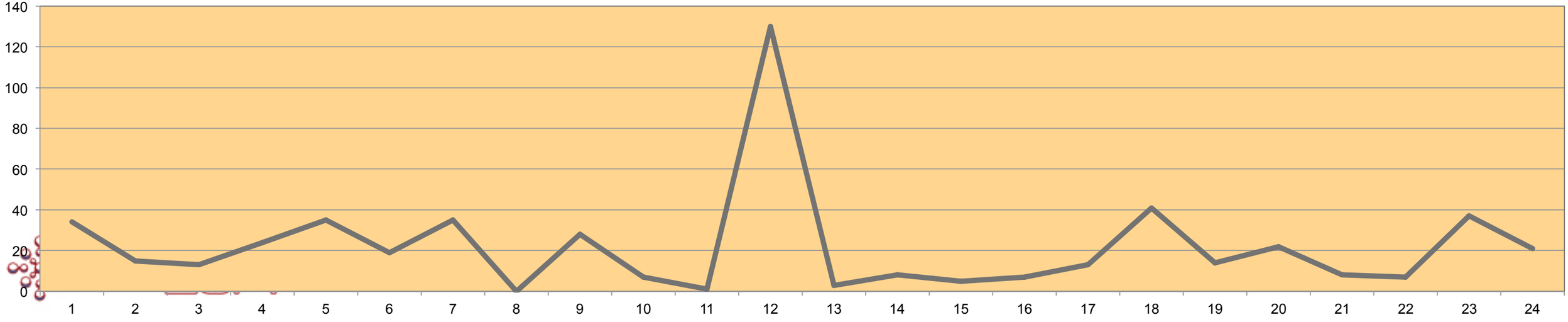
now I gotta do it with the other side and crease that part there

Results (qualitative): Types of “new” contributions

- Reformulations of the original instructions
  - Grammatical or lexical adaption: ‘pointing towards me’
- Object quality
  - ‘so I'm folding that so it's lined up and then straightening out the fold.’
- Comparison with other actions
  - ‘I gotta do it with the other side and crease that part there
- Spatial description
  - ‘that one is horizontal
- Adding semantics
  - ‘kind of like a crane

Results (quantitative): Distribution

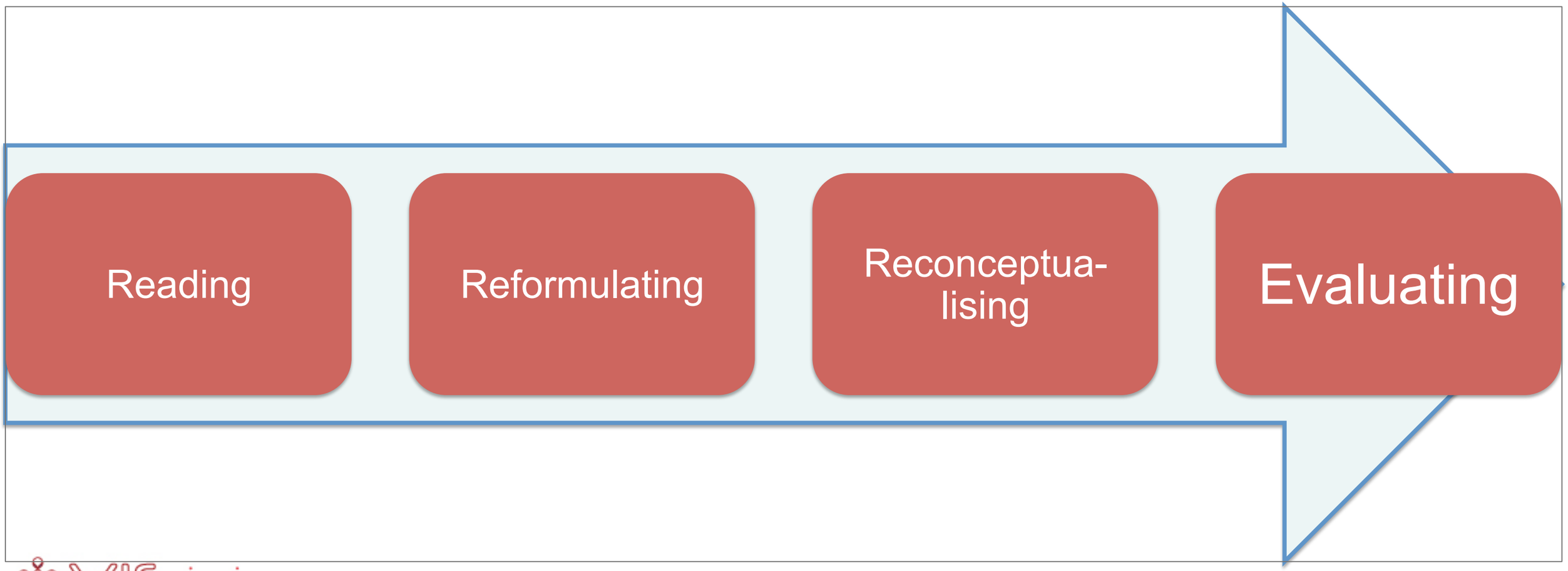
- Number of times people mention own ideas
  - Participants differ widely – some do this regularly almost in every utterance, others never
  - Types of ideas likewise distributed unevenly
- Number of new spatial terms



More categories of utterances (Content analysis)

- *Reading task description*
- *Evaluation*
- *References to Origami background knowledge*
- *Expression of problems*
- *Task communication*
- *Other*

Recurring pattern



Discussion

- Qualitative results reveal thought processes and ideas while solving an Origami problem
- Origami paper folders attend to
  - Quality of the product (alignment, crease)
  - Actions and their relation to each other – similarities and differences
  - Spatial patterns of various kinds
  - Semantic associations

Discussion

- Reconceptualisation is a frequent step in the problem solving process when following complex instructions
  - Comes with considering and applying the instructions
- Individuals differ widely in the extent to which they add in their own thoughts
  - especially concerning spatial content

CODA: Scope & Applications

- CODA has been used to investigate
  - How people perceive and describe complex scenes
    - Architects, painters, & sculptors differ in how they describe spatial scenes (Cialone, UCL)
    - Complex spatial configurations: Concepts & description strategies
  - How people describe their understanding of spatial environments
    - Route descriptions
    - Think aloud protocols of wayfinding situations
  - Other problem solving processes
    - Origami paper folding
    - Object assembly

http://knirb.net

CODA for cognitively supportive visualisations

- CODA methods can be used to address
  - Conceptualisation of diagrams and visual interfaces
    - based on specific ways of perceiving and thinking about them
    - Beyond verbalisability and content analysis: Linguistic patterns reveal conceptual patterns that speakers may not be aware of
  - User evaluation of changes in visual design
    - Controlled think-aloud tasks addressing uptake of visual design decisions under diverse conditions