

Target Users' Diagrammatic Reasoning of Domain-Specific Terminology

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 - Domain-specific terminology and terminological ontologies
 - Research themes (dual visualizations)

- 2) Method and material
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 - Performance (regression) models

- 3) Results: Expertise effects
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 - Reduced, absent and reversed expertise effects

- 4) Results: Trial-number effects and diagrammatic reasoning
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 - **Inferring diagrammatic reasoning**

- 5) Conclusion

1) Introduction

Domain-specific terminology

- The study of terms (further specialized discourse, constitute lexical units and express underlying concepts) [Cabré, 2003]
- Belonging uniquely to a particular domain (specialized discourse) e.g. taxation
- Compile terminological resources (terms, relations, definitions) e.g. term banks

Terminological ontologies

- Introduce formal ontology [Guarino, 1995] into the practice of terminology work [ISO-1087, 2000]
- Model concepts by formal feature specifications of attribute-value pairs [Madsen, Thomsen & Vikner, 2004]
- Visualize concepts, relations and characteristics in the graphical format

RQ: Whether domain-specific terminology and knowledge can be conveyed to target users by means of diagrams...

Dual-entry mode: From the conventional term-bank format to combining...

- Concept diagram in the graph format (denoted D)
- Concept article in the text format (denoted A)

Expertise: From the one-dimensional levels of expertise to suggesting...

- Background variables (participation, motivation, education, exposure)
- Self-rating (direct)
- Representative tasks (indirect)

Experiment: From eye-movements to expertise and trial-number effects...

- Multiple regression technique
- Significant predictors of performance (correctness, speed and depth)

2) Method and material

Sample:

- 40 professional potential target users ... to represent the full scale of expertise ranging from low to high.
- 23 females (mean age 41.7) and 17 males (mean age 44.0)
- Danish native speakers

Expertise background variables [Kwak, 1999]

- **Participation**/Work place: 20 inside and 20 outside Tax Administration/SKAT
- **Motivation**/Working area: 18 JUROKPOL vs. 22 OTHER
- **Education**/Length: 29 long (five years or more) vs. 11 short
- **Exposure**/Frequency of use of specialized texts:
Seven-point Likert-scale (mean 3.54)

(Remote) Eye tracking



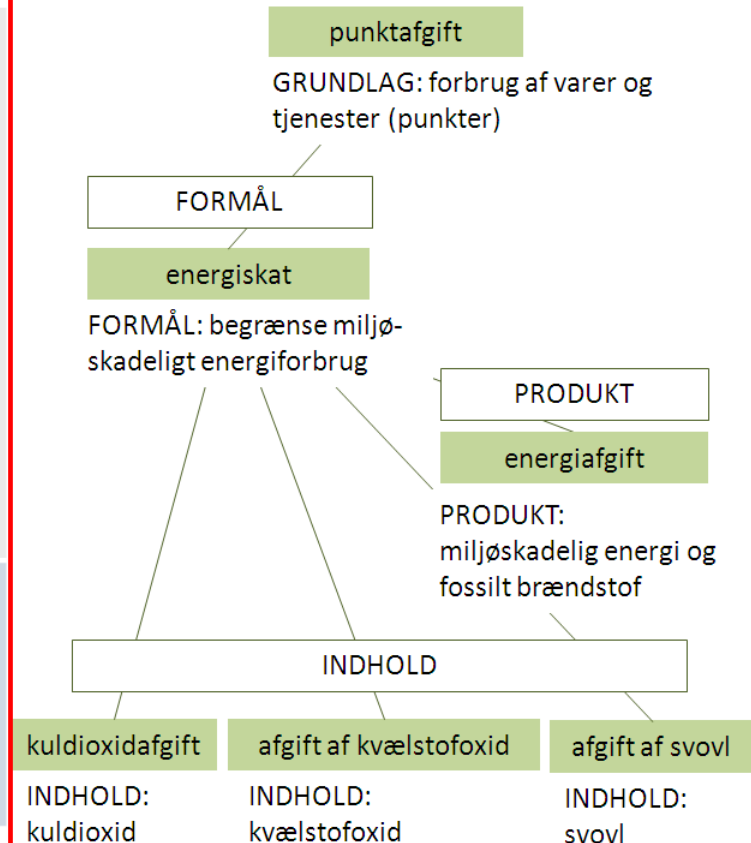
The eye-mind hypothesis:
No appreciable lag between fixation and cognitive processing
[Just & Carpenter, 1980]

Dual-entry mode (Fig. 1)

Hvilken type skat eller afgift er energiskat?

1. Miljøafgift
2. Energiafgift
3. Punktafgift

Dansk:	energiskat
Kilde til term:	Skatter og afgifter 2012 (Danmarks Statistik)
Definition:	punktafgift som pålægges varer og tjenester med det formål at begrænse miljøskadeligt energiforbrug
Kilde:	DanTermBank
Kommentar:	Den største gruppe blandt punktafgifterne er energiskatterne, der i 2011 tegnede sig for 44 pct. af samtlige punktafgifter.
Kilde:	Skatter og afgifter 2012 (Danmarks Statistik)
English:	energy tax
Source for term:	Taxation trends in the EU 2012 (Eurostat)
Definition:	excise duty imposed on energy consumption to reduce emissions
Source:	DanTermBank



8 blocks of 6 questions (Tab. A1)

Question type	Term-bank content	Question	Available answer	Correct answer
Diagram (D1)	Sub-ordinates	How many types of energy taxes exist?	1: Four 2: Six 3: Eight	No. 1
Diagram (D2)	Sub-division criteria	What separates carbondioxide tax from duty on nitrogen oxides?	1: Purpose 2: Content 3: Taxpayer	No. 2
Article (A1)	Equivalents	What can 'energy tax' be translated into in Danish?	1: <i>energiavgift</i> 2: <i>energiskat</i> 3: <i>energitakst</i>	No. 2
Article (A2)	Comments	Energy taxes constituted 44 per cent of excise duties in 2011 according to whom?	1: OECD 2: Eurostat 3: Statistics Denmark	No. 3
Diagram-Article (DA1)	Super-ordinate (Definition)	What type of tax or duty is energy tax?	1: Environmental duty 2: Energy duty 3: Excise duty	No. 3
Diagram-Article (DA2)	Attributes (Definition)	What is the purpose of energy tax?	1: Limiting environmentally damaging energy consumption 2: Limiting environmentally damaging consumption 3: Limiting environmental Damage	No. 1

Heat maps and scan paths

Hvilken type skat eller afgift er punktafgift?

1. Indirekte skat
2. Generel skat
3. Indirekte skat

<p>Indirekte skat OPKRÆVNINGSFORM: indirekte på transaktionen</p> <p>GRUNDLAG punktafgift</p> <p>GRUNDLAG: forbrug af varer og tjenester (punkter)</p> <p>FORMÅL</p> <ul style="list-style-type: none"> energiavgift FORMÅL: begrænse miljøskadeligt energiforbrug afgift af motorkøretøj FORMÅL: begrænse miljøskadelig motorkøretøj miljøafgift FORMÅL: begrænse miljøskadelige produkter og stoffer mv afgift af nydelsesmidler FORMÅL: begrænse sundhedsskadeligt forbrug afgift på spil FORMÅL: begrænse forbrug af spil 	<p>Dansk: punktafgift Kilde til term: Den juridiske vejledning 2012-2 (SKAT)</p> <p>Definition: indirekte skat som pålægges forbrug af varer og tjenester med det formål at begrænse skadeligt forbrug</p> <p>Kilde: DanTermBank</p> <p>Kommentar: Afgifter er enten pålagt <i>generelt</i>, dvs. omfatter samtlige varer og tjenester (moms), eller de er pålagt <i>specielt</i>, dvs. vedrører kun enkelte vare- eller tjenestegrupper (punktafgifter).</p> <p>Kilde: Skatter og afgifter 2012 (Danmarks Statistik)</p> <p>English: excise duty Source for term: Taxation trends in the EU 2012 (Eurostat)</p> <p>Definition: tax imposed on an act or transaction</p> <p>Source: DanTermBank</p>
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Experimental procedure

Background questionnaire

- Self-rating task
- Terminology crash course
- Recalling task (List)
- Categorizing task (Define)

Eye-tracking experiment

- Reading task
- **Dual-entry mode (visualization)**

Retrospection (after-the-event interview)

- User situation, preference, performance, difficulty, exposure, user needs

Expert performance guided the choice of dependent variables :

- Representative tasks to demonstrate superior performance of experts [Charness & Tuffiash, 2008]
- Expert performance characteristics: deep, error-free and fast [Rikers & Paas, 2005]
- DVs: correctness, response time (defined as the sum of processing and answering time on each question.) and diagram-fixation time (defined as the sum of all fixations over 200 ms on the screen in the relevant AOI).

Multiple regression techniques (linear mixed-effects modelling) [Balling, 2008]:

- To model dependencies in the observations as the answers of each participant are not considered independent
- To assess multiple correlations of explanatory (independent) variables with a specific (dependent) performance variable

3) Results: Expertise effects

(No) Expertise effects

Expectation: Expertise effects from the subset of explanatory variables measuring expertise levels (directly or indirectly)

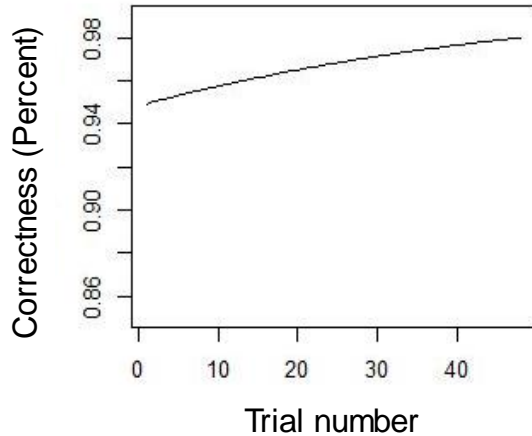
Result: No explanatory variables reflecting expertise are significant predictors of performance

Interpretation

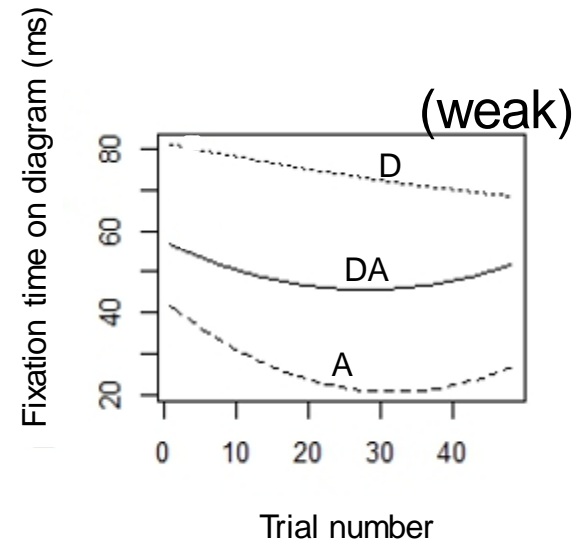
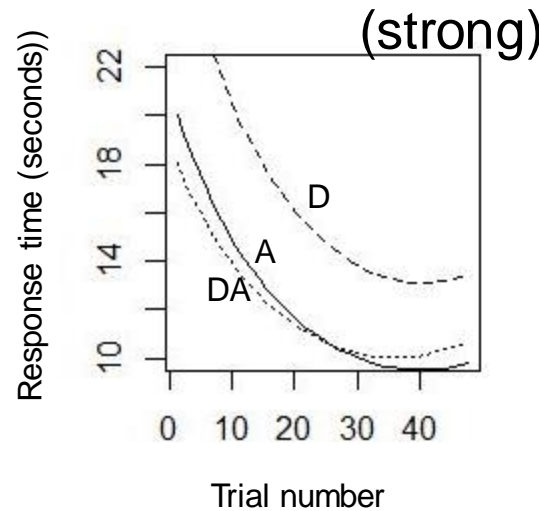
- Reduced: Overload of limited processing capacity [Mayer & Moreno, 2003]
- Absent: Expertise measures do not fully capture complexities [Alexander, 1992]
- Reversed: Information redundancy [Kalyuga & Sweller, 2004]

4) Results: Trial-number effects and diagrammatic reasoning

Trial-number effects (Fig. 2)



Significant interaction between performance and question type



- D-questions require significantly longer **response time** compared to A- and DA-questions
- D-questions require significantly longer **diagram-fixation time** compared to A- and DA-questions
- DA-questions require significantly longer **diagram-fixation time** compared to A-questions.

Interpret the trial-number effects of the performance models to infer the underlying diagrammatic reasoning...

Correctness:

- D-questions are not resulting in lower correctness
- Diagrammatic reasoning of diagrams as **effective** as “non-diagrammatic reasoning” of articles

Response time (on correct answers)

- D-questions are more (response) time consuming
- Diagrammatic reasoning of the D-questions is the **least efficient** compared to A- and DA-questions

Diagram-fixation time (on correct answers)

- DA-questions: Diagrams are fixated but without longer total response time... therefore, answers are probably not retrieved from D!
- Diagrammatic reasoning is most likely **inefficient**

5) Conclusion

Conclusion

Access to dual visualizations of domain-specific terminology:

Conclusion based specifically on the diagrammatic reasoning:

It depends on the information need (question type) of target users:

- D-questions: Evidence for effective and improving diagrammatic reasoning
- DA-questions: Evidence for inefficient diagrammatic reasoning

Conclusion based on general knowledge acquisition:

Terminological ontologies should be an integral feature of in the interface of terminological resources

- Target users are able to reason about diagrams despite relatively long reasoning and response times.

Thank you!