Implicatives:
What had been done
What needs to be done

Based on work by Lauri Karttunen
with Cleo Condoravdi, Rowan Nairn and Ignacio Cases
and on work by Baglini & Francez and Nadathur
Lauri’s interests

• FS morphology
• Semantics
  • Questions
  • Reference
  • Verbal complementation
    • Presuppositions
    • ...
    • Implicatives
Outline

• What are implicatives? What is interesting about them?
• What Lauri and his collaborators did about the implications of implicatives
• What Lauri and other researchers did about the presuppositions of implicatives
• What needs to be done
Implicatives

• What are implicatives: examples
  
  Two-way implicatives: Manage, remember to, dare, bother, care, happen; Forget to, fail, neglect, avoid,
  One-way implicatives: Force; Prevent

  Simple: see above
  Phrasal: Be able, take/have/make the time/opportunity/trouble, be possible,

• Three questions about speaker commitment:
  
  • What are the entailments/implications for the embedded complement given the matrix predicate?
  • What are the presuppositions/conventional implicatures of the implicative predicate?
  • What is asserted by the sentence as a whole?
Implicatives: Original papers

• Karttunen, L. (1971a) : Implicative Verbs, Language, 47
• Karttunen, L. (1971b) : The Logic of English predicate complement constructions
Implicatives: Relevant semantic relations

- **Presupposition**: if A then B & if –A then B; where A is the matrix clause predicate and B is the embedded clause
- **Entailment**: if A then B; if –B then –A
- **Implication (Strawson Entailment)**: if A then B but not: if –B then –A
- **Conventional implicature**: if A then B except ...
Semantic Relations in Implicative and in Factive Predicates (*that* and *to* complements)

- **Implication**
  - Joan remembered to finish her paper $\rightarrow$ Joan finished her paper.
  - Joan didn’t remember to finish her paper $\rightarrow$ Joan didn’t finish her paper.
    - $\rightarrow$ remember to is an implicative verb
    - Why not entailment? Finish paper $/$ remember to finish paper

- **Presupposition**
  - Betsy remember that Joan finished her paper. $\rightarrow$ Joan finished her paper. (Factive verbs)
  - Betsy didn’t remember that Joan finished her paper. $\rightarrow$ Joan finished her paper.
    - $\rightarrow$ remember that is a factive predicate
  - Joan remembered to finish her paper. (Implicative verbs)
  - Joan didn’t remember to finish her paper.
    - $\rightarrow$ finishing her paper involved a memory effort/intention?

- **Conventional implicature**
  - Joan had the time to finish her paper
    - ... but she chose to go to the movies instead

- ...
Two-way implicatives

• ++/--Implicative  (manage, remember, true)
  • John managed to open the bottle.
    • ==> John opened the bottle.
  • John didn’t manage to open the bottle.
    • ==> John didn’t open the bottle.

.+/-/+Implicative  (fail, forget, neglect, not, false)

  John forgot to open the bottle.
    ==> John didn’t open the bottle.
  John didn’t forget to open the bottle.
    ==> John opened the bottle.
Notation(s)

(secondary place) + indicates (Strawson) entailment,
(secondary place) − indicates contradiction,
(secondary place) o stands for permits

<table>
<thead>
<tr>
<th>example</th>
<th>Positive form of verb</th>
<th>Negative form of verb</th>
<th>Form of verb</th>
<th>implication</th>
<th>Form of verb</th>
<th>implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>manage</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>fail</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>force</td>
<td>+</td>
<td>o</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>o</td>
</tr>
<tr>
<td>refuse</td>
<td>-</td>
<td>o</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>o</td>
</tr>
<tr>
<td>be able</td>
<td>o</td>
<td>-</td>
<td>+</td>
<td>o</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>hesitate</td>
<td>o</td>
<td>+</td>
<td>+</td>
<td>o</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>take no time</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(second place) + indicates (Strawson) entailment,
(second place) − indicates contradiction,
(second place) o stands for permits
One-way +implicatives

• ++/-o Implicative \((force, cause)\)
  - Ed forced Mary to leave.
    \(\rightarrow\) Mary left.
  - Ed didn’t force Mary to leave.
    \(\rightarrow\) ??? (so she stayed / she left voluntarily)

+-/-o Implicative \((prevent, avoid, be too ADJ)\)

Ed prevented Mary from leaving.
  \(\rightarrow\) Mary didn’t leave.
Ed didn’t prevent Mary from leaving.
  \(\rightarrow\) ??? (so she left / she stayed voluntarily)
One-way -implicatives

• +o/--Implicative (*be able, have the time*)
  • Mary had the time to read your paper
    ➔ ??? Mary read your paper
  • Mary didn’t have the time to read your paper
    ➔ Mary didn’t read your paper
• +o/+ Implicative (*hesitate*)
  • Mary hesitated to read your paper
    ➔ ???? Mary read your paper
  • Mary didn’t hesitate to read your paper
    ➔ Mary read your paper
What Lauri and his collaborators did about implications of implicatives

• Develop a computational approach to embedded implicatives
• Study the productivity of phrasal implicatives
• Study the learnability of phrasal implicatives
What was done by Lauri and others about the presuppositions of implicative verbs

- Determine the necessary and/or sufficient conditions for the felicitous use of the implicative predicate
  - Joan managed to finish her paper.
  - Joan finished her paper.
- Define the relation between matrix verb and complement
What Lauri and collaborators did about implications of implicatives
1. Embedded implicatives

• First discussed in Karttunen (1971b): Works out the logic for
  • Bill didn’t have the foresight not to force Mary to prevent Sheila from having
    an opportunity to try that new detergent $\rightarrow$ Sheila did not try the new
    detergent.

• Implementation in Nairn, Condoravdi and Karttunen (2006) in PARC XLE:
  • Ed did not forget to force Dave to leave.

• Other slightly later implementation: MacCartney’s Natural Logic.
Implications: Nairn, Condoravdi, Karttunen (2006): A computational approach

- Veridicality relations between contexts determined on the basis of a recursive calculation of the relative polarity of a given “embedded” context
- Globality: The polarity of any context depends on the sequence of potential polarity switches stretching back to the top context
- Top-down each complement-taking verb or other clausal modifier, based on its parent context's polarity, either switches, preserves or simply sets the polarity for its embedded context
Polarity propagation

“Ed did not forget to force John to leave“

“John left“.

In following: assume dependency grammar backbone
Ed
---
not
-+-+ Implicative

forget
-+-+ Implicative

Ed
---
force
++ Implicative

Dave
---
leave

Dave
Approach depends on list of implicatives with their signatures
2. Phrasal implicatives

• Many more phrasal implicatives than simple ones: Lauri identified more than 300 for English
• Some patterns of verbs and nouns can be detected (note that these pattern give an indication of the presuppositions attached to them).
Phrasal two-way implicatives

• ++|--
• *have the courage, wisdom*
  Julie had the chutzpah to ask the meter maid for a quarter.
  I didn’t have the courage to tell her that I loved her.
• *meet an obligation*
  We clearly fulfilled the obligation to pass a balanced budget.
  Strausser hasn’t met his responsibility to make improvements.
• *take the effort, asset, opportunity*
  She took the trouble to iron all the clothes.
  I just didn't take the time to care for myself.
**use an asset, opportunity**

I used the money to buy shoes and food.

Randy didn’t use the opportunity to toot his own horn.

**waste an asset**

I wasted the money to buy a game that I cannot play.

I’m glad I didn’t waste 90 minutes to see this film.

**waste an opportunity**

Mr. Spitzer wasted the opportunity to drive a harder bargain.

She didn't waste the chance to smile back at him.

**fail an obligation**

The Avatar failed his duty to bring peace to a broken world.

Orlando didn't neglect his duty to escort the dead.
Phrasal one-way implicatives

- | 0
lack opportunity
   She lost the chance to qualify for the final.

0 | -
have ability
   The defendant had no ability to pay the fine.
make effort
   I have made no effort to check the accuracy of this blog.

0 | +
show hesitation
   She did not have any hesitation to don the role of a seductress.
   Fonseka displayed no reluctance to carry out his orders.
<table>
<thead>
<tr>
<th>VERB FAMILY</th>
<th>NOUN FAMILY</th>
<th>IMPLICATIVE SIGNATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAVE</td>
<td>ABILITY</td>
<td>OPPORTUNITY</td>
</tr>
<tr>
<td>LACK</td>
<td>ABILITY</td>
<td>OPPORTUNITY</td>
</tr>
<tr>
<td>MAKE</td>
<td>EFFORT</td>
<td>○</td>
</tr>
<tr>
<td>MEET</td>
<td>OBLIGATION</td>
<td>+</td>
</tr>
<tr>
<td>FAIL</td>
<td>OBLIGATION</td>
<td>−</td>
</tr>
<tr>
<td>SHOW</td>
<td>HESITATION</td>
<td>○</td>
</tr>
<tr>
<td>TAKE</td>
<td>ASSET</td>
<td>EFFORT</td>
</tr>
<tr>
<td>USE</td>
<td>ASSET</td>
<td>OPPORTUNITY</td>
</tr>
<tr>
<td>WASTE</td>
<td>ASSET</td>
<td>+</td>
</tr>
<tr>
<td>WASTE</td>
<td>OPPORTUNITY</td>
<td>−</td>
</tr>
</tbody>
</table>
Phrasal Implicatives

- I *had the time* to read your paper (invited inference)
- I *took the time* to read your paper (implication)

- Convair made a **futile** attempt to save their bomber program
  - → they didn’t save it
- Convair made a **successful** attempt to save their bomber program
  - → they did save it

- Karttunen (2012) Simple and Phrasal Implicatives
  - Subtle/productive → listing impossible
3. Learnability

- General purpose corpora, even if big like SNLI, do not contain enough information for neural networks to learn the implications of implicatives.
- A version of the corpus should be available at: https://nlp.Stanford.edu/projects/sci/
- Around 90 constructions represented by triplets (premise, hypothesis, entailment label), three of which are not implicatives (e.g. make promise), seeds from Google Books and the web.
  - *We have missed an opportunity* to examine the art market today
  - Contradicts
  - *We have examined the art market today*
Corpus construction with positive seeds

- From the seeds, negative versions were constructed: We get four patterns for two-way implicatives: positive premise entails the hypothesis, positive premise contradicts the negated hypothesis, negative premise entails the negated hypothesis, negative premise contradicts the hypothesis; For one-way implicatives we get: positive premise permits the hypothesis, positive premise permits the hypothesis, negative premise entails the negated hypothesis, negative premise contradicts the negated hypothesis.
- Special cases and variation in tenses, some seeds generated 18 variants.
- About 11K premise-hypothesis pairs.
- Little grammatical variation, e.g. all NPs are definite descriptions, pronouns or proper names, no quantifiers.
- 20 nested constructions (?)
Corpus and invited inferences

• The corpus also encodes invited inferences for some expressions
• One-way implicatives often have an invited inference in the polarity for which the implication doesn’t hold:
  • I didn’t have the time to read your paper → I didn’t read your paper
  • I had the time to read your paper: invited inference: I read your paper
• The likelihood of the inference varies from construction to construction, the corpus gives probabilities for those.
Experiments with the corpus

• **Lexical logistic regression classifier** with various features (length of hypothesis, unigrams, bigrams, bleu score between premise and hypothesis): not published

• **Bag-of-words with feedforward neural network**: not published

• **Sequence to sequence recurrent neural network (RNN)**: not published

• **Recursive routing network (RRN)**: some results published in Cases (2019) and Cases and Karttunen (2020)

• **Four different subsets**: Joint/disjoint/mismatched, Nested.
Desiderata (from Cases and Karttunen, 2020)

1. Basics.
The model should have a good test performance on sentences containing implicative constructions it has seen in training.

2. Generalization.
The model should be able to generalize in the way people do to unseen lexical items and longer sequences.

3. Composition of signatures for nested implicatives.
Main problem
Experiment with implicatives

Use signatures to define routing paths to the generalization
Then try to generalize without the signatures

<table>
<thead>
<tr>
<th>Routing</th>
<th>joint</th>
<th>disjoint</th>
<th>mismatch</th>
<th>nested*</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>57.26±0.18</td>
<td>55.68±0.47</td>
<td>53.41±0.86</td>
<td>50.98±0.92</td>
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<tr>
<td>WP+D</td>
<td>75.56±0.77</td>
<td>74.87±0.49</td>
<td>71.08±0.52</td>
<td>75.43±0.29</td>
</tr>
<tr>
<td>Basic Dispatch</td>
<td>72.7</td>
<td>65.05</td>
<td>67.74</td>
<td>80.35</td>
</tr>
<tr>
<td>AE Dispatch</td>
<td>71.4</td>
<td>64.13</td>
<td>67.7</td>
<td>83.24</td>
</tr>
</tbody>
</table>
Learnability

• Limited variation in patterns: doesn’t come close to the richness of Karttunen (2012)
• Not many nested implicatives, results most likely not very significative
• Overall results show that newer methods give better results but that there is still little generalization
• Are the methods used still the best available?
What was done by Lauri and others about the presuppositions of implicative constructions
Presuppositional/non-at-issue and propositional/at-issue content of implicatives

• Karttunen 1971
• ...let us ignore the individual differences among implicative verbs and try to state precisely in what respect they are all alike. Let v stand for any implicative verb and S for the sentence that manifests itself as the infinitival complement of that verb in the surface structure. I assume that, in the representation of the main clause, v(S) constitutes the central part of the proposition to which negation, modals, and time and locative references are attached. Leaving out these other details, the semantic analysis of the whole sentence can be represented by the following schema:
  • Presupposition: v(S) is a necessary and sufficient condition for S
  • Proposition: v(S)
Presuppositional/non-at-issue and propositional/at-issue content of implicatives

• Attempts to pin down the meaning of *manage* (*be able*):

• Karttunen and Peters (1979): doing A (content of complement) was difficult for S (subject of main clause) (seen as a *conventional implicature*); the *assertion is the same for a simple sentence without the implicative matrix and for the compound sentence with the implicative matrix*

• Coleman (1975), Blatt (1999), Baglini and Francez (2016)
Baglini and Francez (2016) on manage

• Very abstract presupposition, what is exactly presupposed with depend on the actual circumstances
• Very context dependent theory of causation based on Pearl (2000) and Schultz (2011)
• Assertion linked to implicative is not trivial
  • Adverbs
    • a. John hardly/barely managed to eat his dinner.
    • b. John hardly/barely ate his dinner.
  • Because (Karttunen, 1971)
    • John managed to buy the ring because it was cheap
    • John bought the ring because it was cheap
Beyond manage: Prerna Nadathur

- Beyond manage: dare, condescend, & Finnish examples
  - She dared/didn’t dare to meet the speaker
  - Presumes: meeting the speaker required courage/overcoming fear
- With all implicatives there is an obstacle to be overcome
- In two-way implicatives the necessary and sufficient conditions are causally necessary and sufficient.
- In one-way implicatives we have only a necessary condition, not the sufficiency one.
- Implicative verbs like dare highlight causally-determinative (necessary & sufficient) prerequisites for their complements, for verbs like manage the prerequisites are very bleached (depend on specific context)
The prerequisite account (Nadathur 2019, 2022): Karttunen (1971) spelled out and formalized

For two-way implicative I, agent x, 1-place predicate P, I(x,P):

• i. **Presupposes**: the existence of a one-place predicate A such that A(x) is causally necessary for P(x) in context
• ii. **Asserts**: A(x)
• iii. **Presupposes**: A(x) is causally sufficient for P(x)

Implicatives vary w.r.t. the nature and specificity of A: e.g.

- *dare* names specific conditions for P(x) (courage)
- *manage* presuppose underspecified causal conditions.

The assertion is not equal to the embedded complement, in fact the truth or falsity of the embedded complement follows from the causal relation given the assertive status of the matrix predicate. (causal relation is not in Karttunen, 1971)
Causal Relation? Unsettled conditions (example from Nadathur 2022)

• Context. A hunter lost count of the number of times he had fired his gun and was not sure if he had any bullets left. He decided to check after eating and put his gun down to get some food from his pack. While he had both hands occupied, he saw a bear coming towards him.

• Did the hunter shoot the bear?
  • #H’an eht-i ampu-a karhu-n
  • he.nom have.time-pst.3sg shoot-inf bear-gen/acc
  • ‘He had enough time to shoot the bear’
  • informant comment: “you cannot use ehti‘a, because if he didn’t have any bullets, he could not have shot the bear”
Causal Relation? (Example from Nadathur 2022)

• Context. Being 21 is legally necessary & sufficient to drink alcohol. Amira has been eager to try wine for a long time but hasn’t yet because she is very law-abiding. She just turned 21.

• ??Yesterday, Amira managed to drink a glass of wine.
  • to justify manage, infer non-legal conditions (the difficulty of obtaining wine, Amira’s potential distaste for it)
  • these inferences are about potential causal obstacles for P(x)
Extending the account: polarity-reversing implicatives (fail, forget to:+-/-+)

• To capture polarity-reversing verbs:
  prerequisite A(x) is causally necessary/sufficient for complement failure
• matrix negation precludes complement failure: −+ inference
• for two-way verbs: positive assertion (A(x)) guarantees complement failure (+−) inference
Extending the account: one-way implicatives

• She had the time to read the paper ?-→ she read the paper
• She did not have the time to read the paper→ She did not read the paper.
• Ideally the assertion shouldn’t change
• *Have the time* simply drops the sufficiency presupposition
• both one- (−−/oo) and two-way (+ + / − −) verbs assert prerequisite satisfaction
• failure of necessary prerequisite produces −−/oo entailment
• satisfying a necessity-only prerequisite does not guarantee the complement, so we don’t get the ++ inference
Cover relation

Ann hesitated to ask

Ann did not hesitate to ask

Ann did not ask

Ann asked
One-way implicatives and cover relation

All the one-way implicatives are in a cover relation:

• Ann was able to speak. 专项斗争 Ann did not speak.
• Ann did not refuse to speak. 专项斗争 Ann did not speak.
• Ann was not forced to speak. 专项斗争 Ann spoke.
• Ann hesitated to speak. 专项斗争 Ann spoke.
To be done

- Relation between invited inference and implication
- Detailed relation between Lauri’s tables and Prerna’s proposal:
  - specify the prerequisites for all the cases. E.g. what are they for forget? Lauri claims: intention, in Prerna’s view? It all needs to be spelled out.
  - Is Pearl causality the right notion?
- Cross linguistic studies: Finnish has more implicatives than English? Why?
- Learnability: need more subtle corpora, need testing with new models, work with Ignacio Cases interrupted by Lauri’s health problems
Thanks
References

- Baglini & Francez (2016), The implications of managing. *JSem* 33, 541-560
- Cases, I., L. Karttunen, G. Supaniratisai, A. Chaganty (n.d.) An annotated Corpus of Implicative Constructions
- Cases, I & L. Karttunen (2020), Reasoning with Implicatives, slides of the NALOMA workshop
- Coleman, L. (1975), The case of the vanishing presupposition. *BLS1*, 78-89


• Nadathur, P. (2022), Causal semantics for implicative verbs. ling.auf.net/lingbuzz/006510


• Pearl, J. (2000), *Causality: Models, Reasoning and Inference*.

• Schultz, K. (2011), If you’d wiggled A, then B would’ve changed. *Synthese 179*, 239-251