Who did What to Whom: A Cross-Linguistic Investigation

Karin Stromswold (karin@ruccs.rutgers.edu)
Dept. of Psychology & Center for Cognitive Science
Rutgers University

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Cognitive & Neural Bases of Language

Questions to be addressed

• What cues do people use when they assign grammatical roles/thematic roles?
  Word order
  Morphological
  Semantic (thematic roles/lexical)
  Prosodic/Acoustic

• Do children and adults use the same cues?
• Do speakers of different languages use the same cues?

Collaborators

• Postdocs: J. Venditti, I. Sekerina
• Grad Students: N. Batman-Ratyosyan, M. Chen, C. Veitch, S. Zola
• RAs: A. Cigli, J. Eisenband, D. Molnar, J. Ratzan,
• Key Undergrads: C. Hayden, E. Norland, M. Tare

Comparison of English & Turkish

• English:
  Inflectionally impoverished, fixed word order
  Word order conveys grammatical relations

• Turkish:
  Inflectionally rich (agglutinative), free word order
  Inflections convey grammatical relations
  Word order conveys discourse/pragmatic info

English Actives and Passives

• Actives: Mary was pushing Bill (full active)
  Mary was pushing (truncated active)
  Production: children never make mistakes
  Comprehension: children better than chance by 24 mos
• Passives: Bill was pushed by Mary (by passive)
  Bill was pushed (truncated passive)
  Production: By passives rare in adult & child speech
  Comprehension: Children at or near chance until age 4.
  Processing: Even normal adults find passives harder
English Grammatical & Thematic Roles

- Actives: The girl hit the boy
  Agent V Patient
  S V O

- Passives: The girl was hit by the boy
  Patient V Agent
  S V O

- OSV constructions are rare & limited:
  (Reduced RC: The boy the girl hit was mean.)
  Focus *The boy the girl hit.
  Better with stress (e.g., The boy the girl hit vs THE BOY, the girl hit.)
  Better in contrastives (e.g., Bill, Mary hated, and Jim, Sally hated)
  Better with case-marking (Hi, Him, I like)
  Better is semantically irreversible (e.g., The cake, Mary baked; That, Mary baked)

Expt 1: Sentence-picture matching

Active: e.g., The girl was pushing the boy
Passive: e.g., The girl was pushed by the boy

Design

- Sentences (All pre-recorded & digitalized)
  12 Actives: e.g., The girl was pushing the boy
  12 Passives: e.g., The girl was pushed by the boy
  30 Fillers (adults only)
- Verbs: touch, tickle, push, shove, kiss, sniff
- NP pairs: girl & boy; woman & man
- 6 verbs x Act/Psv x Adult/Child pairs = 24 trials
- Subjects: All normal, native monolingual English
  Preschool: N = 17 (3;1-4;8, mean 3;10). Error rates, RTs
  School-age: N = 16 (4;9-7;4, mean 5;8). Error rates, RTs, Eye movements
  Adults: N = 23. Error rates, RTs, Eye movements

Trials

CHILD TRIAL
- Fixation: Look at Woody
- Critical: Which picture shows …
  The girl was pushing the boy
- Reward: Cartoon on side of screen child chooses

ADULT TRIAL
- Fixation: Look at the cross
- Critical: Which picture shows …
  The girl was pushing the boy
- Distractor: Which picture shows …
  The boy was wearing the blue shirt

Accuracy Rates

Reaction Times for Correct Trials
Where do people look as they hear ....

A: The girl was pushing the boy/The boy was pushing the girl
P: The girl was pushed by the boy/The boy was pushed by the girl
Summary of Expt 1

- Children and adults process passives in different ways
  - Adults: process on-line. No active bias.
  - Children: process off-line. Have an “active” bias.
- They first “decide” a sentence is active at different points
  - Adults: at or before the verb stem (i.e., before participle)
  - Children: at or after the progressive participle
- They first decide a sentence is passive at different points
  - Adults: at the passive participle
  - Children: after the sentence is over

Expt 2: Acoustics and Passives

- Question: Why can adults disambiguate between actives and passives so early?
- Answer: There must be acoustic differences before the active/passive participle
- Analyses
  - Trained phonetician analyzed all stimuli using ToBI system and found no consistent differences between actives and passives
  - Analyzed duration, amplitude, frequency of morphemes

Gating Experiment

- Task: Guess how cut-off sentences end
  - Was: The boy was pushed by the girl
  - Verb stem: The boy was pushing the girl
- Stimuli: 6 verbs x act/psv x 4 NPs x 2 cuts = 96
- Presentation: pseudorandom order, self-paced
- Subjects: 22 monolingual English college students
- Results
  - Better on actives (74% vs. 58%, p = .015)
  - Better on verb stem (83% vs. 49%, p < .0005)
  - Verb x active/passive interaction (p = .006)
Summary of Experiment 2

- There are acoustical differences between actives and passives prior to the point of morphological disambiguation
- Adults are able to use these cues to disambiguate actives and passives
- But maybe some of the differences between adults and children are due to the pared down (boring) task

Passive Toy 1: Design

- Subjects: All normal, native monolingual English
  - Preschool: N = 20 (3;0-4;7, mean 3;10). Errors, RTs
  - School-age: N = 19 (4;9-7;3, mean 5;9). Errors, RTs, Eye-movements
  - Adults. N = 20. Errors, RTs, Eye-movements
- 4 critical sentence types (all prerecorded and digitized)
  - By-less Actives: The cow was kicking
  - By-less Passives: The cow was kicked
  - By Locative Actives: The cow was kicking by the sign
  - By Passives: The cow was kicked by the horse
- 8 verbs (chosen to be felicitous in each type of sentence):
  - ed passive participles: kicked, licked, scratched, pushed
  - en passive participles: thrown, shaken, drawn, beaten
  - Each sentence type with 2 -en and 2 -ed verbs
- An implicit object present for all trials (e.g., lick --> lollipop)

Passive Toy 1: Overall Correctness Rates

Passive Toy 1: First NP Correct Rates

Act-Out 1: Reaction Times for Correct Trials
The cow was kicking by the post
The cow was kicked by the horse
The cow was kicked
The cow was kicking by the horse
The cow was kicking by the sign
The cow was kicked by the horse

Child Passive Toy 1: Looks to 1st NP for Actives
Child Passive Toy 1: Looks to First NP for Passives
Child Passive Toy 1: Looks to First NP for By-less Sentences
Child Passive Toy 1: Looks to 1st NP for By Sentences

Adult Passive Toy 1: Looks to 1st NP for Actives
Adult Passive Toy 1: Looks to 1st NP for Passives
The cow was kicked by the horse
The cow was kicking by the sign
The cow was kicked by the horse
The cow was kicking

Possible reasons for adult errors
Adults: 100% for +by passives & -by actives
85% for -by passives; 94% +by actives

Speed/accuracy tradeoff: Unlikely
Problems with animals & props:
• Locations weren’t locative enough?
• Animals weren’t equally plausible as agent/patient?
• Animals differed in visual salience?
• Differences in frequency/syllables?

Acoustics: ?Male speaker, ?less acoustic cues

It is real.
Spoken English Analysis: By
• Corpora: Adult speech to 10 children (CHILDES)
• Results:
  Full by-passives are rare: 25
  By-locatives with progressive verbs are even rarer: 6
    ?Nathan18: He’s talking to the handsome pilot by the radio
    Nina 4: Is he standing by the window?
    ?Nina30: Are they going to go by the railroad tracks and see
    the train?
    Nina42: You were sitting by Elizabeth
    ?Sarah82: Are you going to come by here?
    ?Sarah82: Ya going to walk by me?

Spoken English: Truncated Passives
• Corpora: Adult speech to Adam & Abe (CHILDES)
• Results:
  Truncated passives are not rare, but are either
    • Morphologically marked: The man got killed
    • Semantically irreversible: The dish was broken.
• Conclusion: Adults’ comprehension errors could be real and could reflect adults’ on-line parsing strategies.
  • Specific aspects of the experiment may have lead adults to use these strategies.

Passive Toy Experiment 2
• Subjects:
  21 Children (ages 2;11-4;11). Error rates
  29 Adults: Error rates & eye movements
• Sentence types (+ Fillers)
  By-less Actives: The elephant was kicking
  By Locative Actives: The elephant was kicking by the tree
  By-less Passives: The elephant was kicked
  By Passives: The elephant was kicked by the lion
• Verbs: kick, pinch, lick, tap, wash, push, scratch, sniff (each with implied object). Each verb in each sentence type once
• 8 NP pairs: equally plausible as agent & patient, similar in visual salience (size & color), and similar in word length and frequency: horse & cow, hippo & elephant, lion & rhino, squirrel & monkey, penguin & walrus, giraffe & monkey, bunny & frog

Passive Toy 2: Overall Correctness Rates

Passive Toy 2: First NP Correct Rates
The cow was pushing by the cactus.
The cow was pushing by the sign.
The cow was pushed by the horse.
The cow was kicked by the horse.
The cow was kicking by the sign.

Adult Passive Toy 2: Looks to First NP for Actives

Active - By
Active + By

Adult Passive Toy 1: Looks to 1st NP for Actives

Active no by
Active by

Adult Passive Toy 2: Looks to 1st NP for Passives

Passive (No By)
Passive + By

Adult Passive Toy 1: Looks to 1st NP for Passives

Passive no by
Passive by

Adult Passive Toy 2: Looks to 1st NP for By-less Sentences

Active - By
Passive - By

Adult Passive Toy 1: Looks to 1st NP for By-less Sentences

Passive no by
Active no by
Karin Stromswold, Who did what to Whom: A cross-linguistic investigation

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Why better performance in Passive 2?

- More consistent acoustic cues in Passive Toy 2
- No -en passives in Passive Toy 2
  - Passive Toy 1: truncated passive were worst with scratched (80%), beaten (70%), drawn (50%)
  - Passive Toy 1: Active by worst with kicking (89%), throwing (85%) and scratching (90%)
- Toys and props
  - Animals matched better for agent-ness
  - Implied objects more compelling
  - Locatives more location-y

English Conclusions

- It’s hard to interpret sentences on-line and correctly assign thematic roles
- Children assume that the 1st NP is the agent
- Adults will use any and all cues present, especially when sentences violate the Thematic Hierarchy
  - Morphological: by, get
  - Acoustic: duration, amplitude, frequency
  - Semantics: The dish was broken
  [Visual information: Adult looks to implicit object begin to increase at the verb; don’t look at objects initially]

Structure of Turkish

- Highly inflected, agglutinative
  - Subjects never casemarked
  - Objects may be casemarked (O₁) or not (O)
- Free word order
  - All word orders are grammatical with O₁
  - Only SOV and OVS grammatical
  - Word order used for discourse/pragmatics.

Turkish Imitation Studies

- Stimuli: Semantically irreversible, non-casemarked
  - SOV: Hungry man bread ate (Aç adam ekmek ye-di)
  - OVS: Bread ate hungry man
  - *SVO: Hungry man ate bread
  - *OSV: Bread hungry man ate
- Imitation Study 1: 31 children (mean age = 4:5)
- Imitation Study 2: 33 children (mean age = 4:4)
  ⇒ In both studies, children did better on grammatical sentences than ungrammatical sentences (both p’s = .01)
  ⇒ In both studies, the youngest children (mean = 3:3 & 3:5) did better on SOV than OVS sentences (both p’s = .01)
Turkish Judgment Studies

Stimuli: Semantically irreversible, non-casemarked
SOV: Hungry man ate bread (Aç adam ekmek ye-di)
OVS: Bread ate hungry man
*SVO: Hungry man ate bread
*OSV: Bread hungry man ate

Grammaticality Judgments:
Children: N = 9 (mean 5.4)
Preferred grammatical sentences (p = .01)
SOV = OVS; *SVO = *OSV (p’s >.10)
Adults: N = 24
SOV > OVS; * SVO > * OSV (p’s <.0005)

Turkish Comprehension Study 1

Procedure: Act-out comprehension task
Subjects: 30 children (ages 2.11 - 5.6, mean age = 4.1)
Stimuli: Semantically reversible, non-casemarked

SOV
At fil it-sin.
Horse elephant push-OPT
‘Let the horse push an elephant’

OVS
Fill it-sin at.
Elephant push-OPT horse
‘(It was) an elephant (that) the horse pushed’

Verbs: {push), koka (smell), cimdia (pinch), txmko (kick), kuka (hug/hold), dp (kiss, sav (pet/love), döv (beat), ĵir (bite) oksa (pet/caress)

Nouns: cow & horse, bunny & cat, bear & elephant, pig & sheep

Comprehension 1: SOV & OVS

- Children did better on SOV (88% vs. 62%, p < .0005)
- Age x SOV/OVS interaction (p = .05)
- SOV performance improved with age (p = .01)
- Only 3-year olds did better than chance on OVS (68%, p < .01 if chance is 50%)

Pragmatically Infelicitous OVS Stimuli

- Discourse/pragmatics of Turkish word order
  Topic: element moved to initial position
  (Focused: element moved to pre-verbal position)
  (Backgrounded: element moved to post-verbal position)
- O1 are definite, uninflected O are indefinite/plural
1) Thus, objects in OVS were topicalized and indefinite: ‘A sheep/sheeps, the pig chased’
   Solution: Add context to support topicalization
2) Uninflected O with animate Ns are odd without DET
   Solution: Add indefinite DET

Turkish Comprehension Study 1: Children’s Performance on Other Constructions

[Graph showing performance across different constructions and age groups]
Turkish Comprehension Study 2

Procedure: Act-out comprehension task

Subjects: 31 children (ages 2:6-5:6, mean age = 3:9)

4 sentence types: ‘The pig chased the/a sheep’

S det O V: ‘The pig chased a sheep’
S O V: ‘The pig chased the sheep’
O det V S: ‘It was a sheep that the pig chased’
O V S: ‘It was the sheep that the pig chased’

Verbs: it (push), öp (kiss), sev (pet/love), dov (beat), isır (bite), çek (pull), oksu (pet/caress), kokla (sniff/smell).

Design: SOV/OVS x ± Inflection x ± Context = 8 trial

Context SOV

Context sentence: SV
‘In this game, pigs* take part’
Bu oyun-da domuzlar oyna-sın
This game-Loc pig-Pl play-Opt

Trial sentence: SOV
‘The pig kissed a sheep’
Domuz bir kuzu öp-sün
Pig a sheep kiss-Opt

† Plural to allow for indefiniteness

Context OVS

Context sentence: SV
‘In this game sheep† take part’
Bu oyun-da kuzu-lar oyna-sın
This game-Loc sheep-Pl play-Opt

Trial sentence: OVS
‘The pig kissed a sheep’
Bir kuzu öp-sün domuz
A sheep kiss-Opt pig

† Plural to allow for indefiniteness

Turkish Compreh. 2: Word Order

![Graph showing SOV and OVS performance](image)

(p = .02)

Turkish Compreh 2: Inflection

![Graph showing no inflection and inflection performance](image)

(p = .03)

Turkish Compreh 2: Word Order x Inflection

![Graph showing interaction between word order and inflection](image)

(p = .01)

Casemarking O only improves performance on OVS (p < .001)
Context and 2-year olds

- We aren’t sure why context hurts 2-year olds
- But, that context does hurt suggests that discourse/pragmatics doesn’t come for free
  - Need exposure to a language to learn D/P rules for that language
  - May need morphosyntax before one can learn D/P
  - May need more exposure to learn D/P than morphosyntax
  - Must understand/model speakers’ intentions to do basic D/P (Theory of Mind?) but not basic morphosyntax

Why aren’t 5 year olds better on OVS?

- Context helped some, but even 5 year olds are quite poor on OVS
- Could OVS comprehension be acquired very late?
- Decided to test adults .....
**Turkish Conclusions**

- It’s hard to interpret sentences on-line and assign thematic roles, especially if grammatical roles can switch order
- Turkish speakers simplify the task by assuming that all sentences are SOV.
- Turkish speakers are only able to interpret OVS sentences when they are given additional cues:
  - Context
  - Prosody
  - Overt object casemarking
  - Semantics

**Spoken Turkish Analysis**

- **Corpora:** 5190 utterances: Our corpora (Turkish mother to her 2 children) + Slobin’s CHILDES x-sectional corpora (5 adults)
- **Results:**
  - Adult utterances with S, V, and O are rare: 7.5%
  - SOV sentences were 3 times as frequent as OVS
  - 75% of sentences had casemarked O
  - Casemarked that are semantically irreversible
    - SOV: 60%
    - OVS: 71%
  - Non-casemarked that are semantically irreversible
    - SOV: 97%
    - OVS: 100%

**Linguistic/Psycholinguistic Implications**

- Every language has one basic word order
  - Acquisition: children learn basic word order first
  - Production: children & adults use this order most
  - Comprehension: children & adults have difficulty understanding other word orders
- Languages have different basic word orders
- Children easily discover the basic word order
- Conjecture: Languages can have different basic word orders because children can learn what this order is (use canonical grammatical --> thematic role mapping)
- Sentences that violate this mapping are hard to acquire and process

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Why aren’t Adults better on OVS?

- NVN: first N = 0; second N = S (i.e., OVS)
  - NNV: first N = S; second N = O (i.e., SOV)
- Maybe uninflected OVS are not grammatical?: But adults rate them more grammatical than SVO or OSV.
- Perhaps OVS are not interpretable (on-line) by adults without strong additional cues
  - Context (i.e., experimental context wasn’t potent enough)
  - Prosody (i.e., prosodic cues weren’t strong enough in expt.)
  - Overt object casemarking
  - Semantics: A bone, the dog ate
  - Discourse: Stronger context needed

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Comprehension of Non-Casemarked +Determiner OVS

- Comprehension of non-casemarked OVS sentences is poor, even if they contain a determiner

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**Determination**

- +Determiner
- +DET only helped for OVS sentences

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**Comprehension of Word Order x Determiner**

- SOV: 100%
- OVS: 80%

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The cow was kicking by the post

Active no by

The cow was kicked by the horse

The cow was kicking by the sign

Child Looks to Implicit Object (No By Sentences)

Child Looks to Implied Object (Passives)

Passive Toy 1: Child Looks to Implied Object

Passive Toy 1: Adult Looks to Implied Object for Actives
The cow was kicked by the horse.
The cow was kicking by the sign.
The cow was kicked.

Passive Toy 1: Adult Looks to Implied Object for Passives

Passive Toy 1: Adult Looks to Implied Object for -By Sentences

Passive Toy 1: Adult Looks to Implied Object for -By Active

Passive Toy 1: Looks to Implied Object for By Actives

Passive Toy 1: Looks to Implied Object of -By Passives
The cow was kicked by the horse.