Event Types in the Mind and in the Corpus

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Verb 2010 - Pisa, 4-5 November 2010

Event Types (ETs)

- Vendler's (1967) classification of predicates:

	[DYN]	[DUR]	[RES]	
STA	-	+	-	*to know, to be tall*
ACT	+	+	-	*to sing, to walk*
ACC	+	+	+	*to write a book, to walk to the fence*
ACH	+	-	+	*to stumble, to die*

- A crucial role in verb semantics: temporal constitution of the sentence

ET of a sentence

- ET of a sentence: result of a complex interaction between the verb and the sentence context (Verkuyl 1972)

- **ET polysemy** (Bertinetto, 1986; Lucchesi, 1971)
  - *impugnare*, “to hold”/“to get hold of”
  - *indossare*, “to wear”/“to put on”

- **ET coercion** (Pustejovsky, 1995; Rothstein, 2004)
  - Guests have been arriving **for hours** (ACH ➪ ACT)

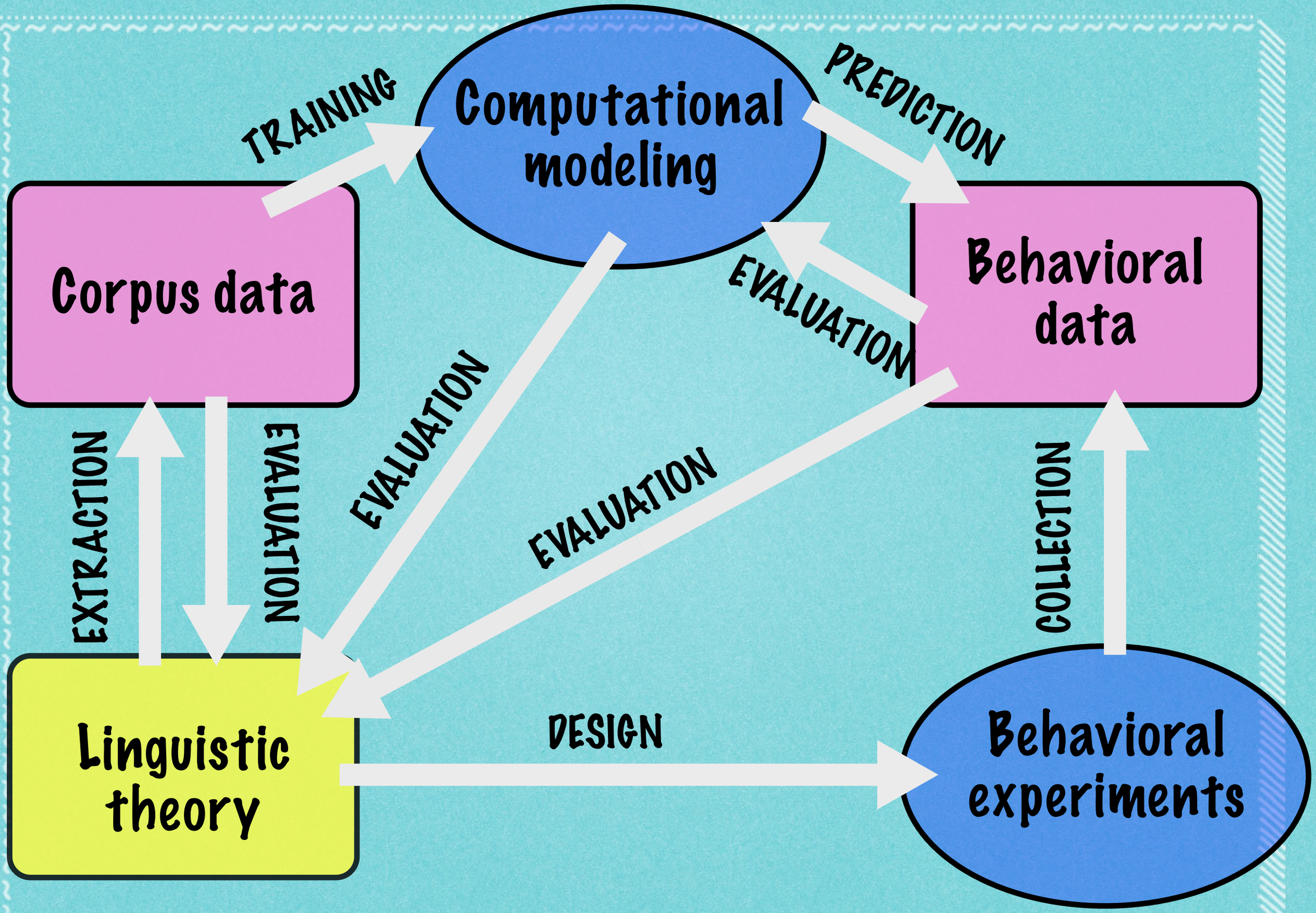
ETs in Experimental Studies

- Acquisition and behavioral studies:
  Antinucci and Miller (1976), Finocchiaro and Miceli (2002), Gennari and Poeppel (2002), Bonnotte (2008), Zarcone and Lenci (2010)

- Computational studies:
  Zarcone and Lenci (2008) and Im and Pustejovsky (2010)

- ETs: one fundamental principle of **organization of the mental lexicon**

- Necessity of an **interdisciplinary approach**


Computational modeling
Corpus data
Behavioral data
Linguistic theory
Behavioral experiments
TRAINING
PREDICTION
EVALUATION
EXTRACTION
EVALUATION
EVALUATION
EVALUATION
COLLECTION
DESIGN

ET in the Mind and in the Corpus

- Goals:

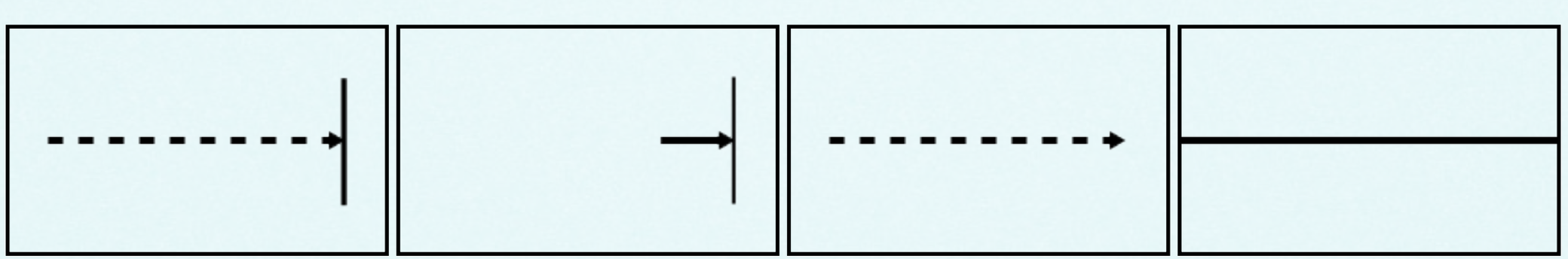
1. Test the speakers' competence of ETs
   - 2 Experiments on verb stimuli (IT-verbs, EN-verbs)
   - 2 Experiments on picture stimuli (IT-pics, EN-pics)

2. Compare the speakers' performance with results from corpus-based models
   - MaxEnt
   - NC

Competence of ETs: task

to stroll

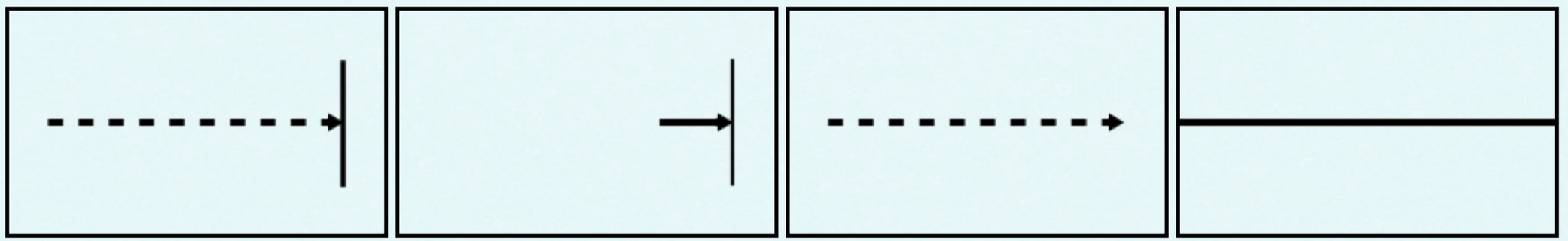
Which of the following symbols best depicts the type of event described?



- Use of pictograms to depict ET classes (Bonotte 2008)

Competence of ETs: task

Which of the following symbols best depicts the type of event described?



Competence of ETs: design

	stimuli	language	materials
IT-verbs	verbs	IT	• 96 trans. VPs (24 ACC, 24 ACH, 24 ACT, 24 STA) • 42 intrans. VPs (21 ACH +21 ACT) = 138 VPs
EN-verbs	verbs	EN	• 96 trans. VPs (24 ACC, 24 ACH, 24 ACT, 24 STA) • 38 intrans. VPs (19 ACH +19 ACT) • 10 “up verbs” (e.g. “drink up”) = 144 VPs
IT-pics	pictures	IT	19 ACC, 40 ACH, 40 ACT, 12 STA = 144 VPs IPNP (Bates et al. 2000)
EN-pics	pictures	EN	

Competence of ETs: design

	subjects	format
IT-verbs	20 every subject saw every item	web-based format
EN-verbs	24 16-22 subjects per item (mean 18)	crowdsourcing experiment
IT-pics	20 every subject saw every item	web-based format
EN-pics	42 10-16 subjects per item (mean 14)	crowdsourcing experiment

Competence of ETs: results

- Binomial logistic regression analysis
  - (correct answer ~ ET * valency * sem_class)
  - (correct answer ~ ET)

- Effect of ET (IT-verbs: $p < 0.05$; others $p < 0.001$)
  - some ET classes are easier to identify than others

- Effect of semantic class ($p < 0.001$)
  (e.g. movement, cognition, etc.)
  - for some sem. classes ET are easier to identify than others

Competence of ETs: results

		α	accur.	ACC	ACH	ACT	STA
IT-verbs	all	0.43	0.63	0.75	0.65	0.61	0.48
	trans.		0.59		0.57	0.53	
	intr.		0.72		0.76	0.69	
EN-verbs	all	0.53	0.68	0.81	0.64	0.68	0.51
	trans.		0.64		0.60	0.64	
	intr.		0.78		0.73	0.82	
IT-pics		0.31	0.42	0.34	0.54	0.60	0.34
EN-pics		0.39	0.54	0.68	0.54	0.50	0.48

IT-V	ACC	ACH	ACT	STA
ACC	**355**	44	62	14
ACH	219	**580**	75	20
ACT	143	62	**531**	141
STA	73	32	138	**224**

EN-V	ACC	ACH	ACT	STA
ACC	**379**	43	47	0
ACH	201	**533**	87	15
ACT	164	59	**582**	56
STA	50	33	128	**219**

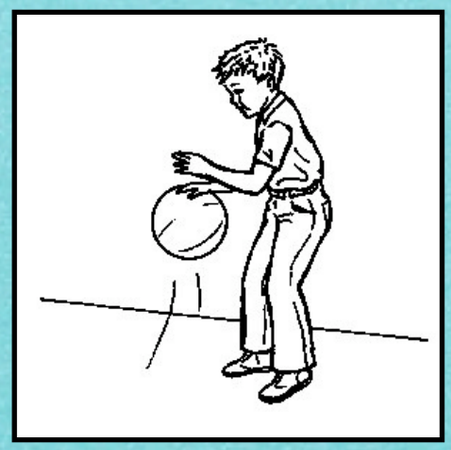
IT-P	ACC	ACH	ACT	STA
ACC	**240**	40	78	21
ACH	208	**377**	146	58
ACT	142	28	**393**	233
STA	45	39	67	**86**

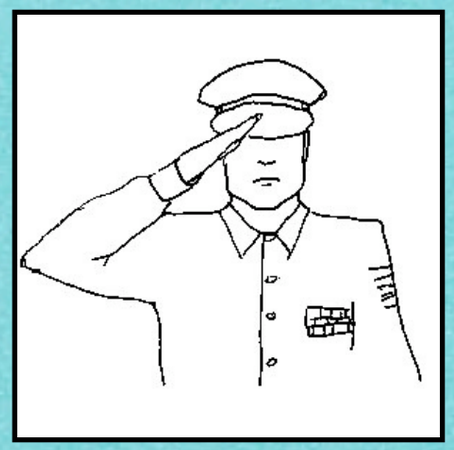
EN-P	ACC	ACH	ACT	STA
ACC	**172**	163	138	29
ACH	53	**294**	41	11
ACT	27	74	**276**	44
STA	2	16	96	**79**

Item-wise analysis

- Items with lower accuracy ➪ polysemous items (multiple ET interpretations):
  - IT-verbs: *formare una fila*, “to form a queue” (ACT/STA)
  - IT-verbs: *scegliere il disco*, “to choose the recorder” (ACC/ACH)
  - EN-verbs: *conceive the theory* (ACC/ACH)
  - EN-verbs: *tumble* (ACH/ACT - iterative)

- One picture, more ETs?





"up" verbs

		base version		"up" version	
	item	[+RES]	[-RES]	[+RES]	[-RES]
[+RES]	*draw [up] the map*	9	8	14	4
	dry [up] the cutlery	17	0	19	0
	lock [up] the box	14	3	18	1
	swallow [up] the syrup	13	5	15	3
	tear [up] the table cloth	16	0	17	0
	wake [up] the doorman	17	1	18	1
	TOT	**83%**	**17%**	**92%**	**8%**
[-RES]	*beat [up] the wife*	16	2	17	2
	eat [up] the strawberries	6	11	16	2
	use [up] the materials	10	7	13	4
	wait [up] for the verdict	19	0	18	0
	TOT	**72%**	**28%**	**89%**	**11%**

Corpus-based models of ETs

- Computational models of ET classification trained with linguistically motivated distributional features
(Distributional semantic approach,
distributional hypothesis, Harris 1954)

- Main ideas:

  - each verb = distributional vector of co-occurrence frequencies with a number of contextual features
  - from distributional features to semantic features:
two verbs with similar context feature distributions = similar ET features

Corpus-based models of ETs

model	type	dataset
MaxEnt (Zarcone and Lenci 2008)	supervised learning	feature extracted for 3129 occurrences of 28 verbs from the Italian Syntactic-Semantic Treebank (Montemagni et al. 2003) 1 vector = 1 verb (token)
NC	nearest centroid method	distributional features vectors extracted from a state-of-the-art dependency corpus of Italian (la Repubblica, Baroni et al., 2004, Bosco et al., 2009) ->138 verbs from IT-VERBS 1 vector = 1 verb (lemma)

Nearest centroid method

- given verb *x*, we sum the other (non-*x*) verb vectors for the ET categories, forming 4 *centroids*
- we compute the cosine distance between *x* and each of the 4 ET centroids
- for *x*, we choose the ET category with the maximum cosine

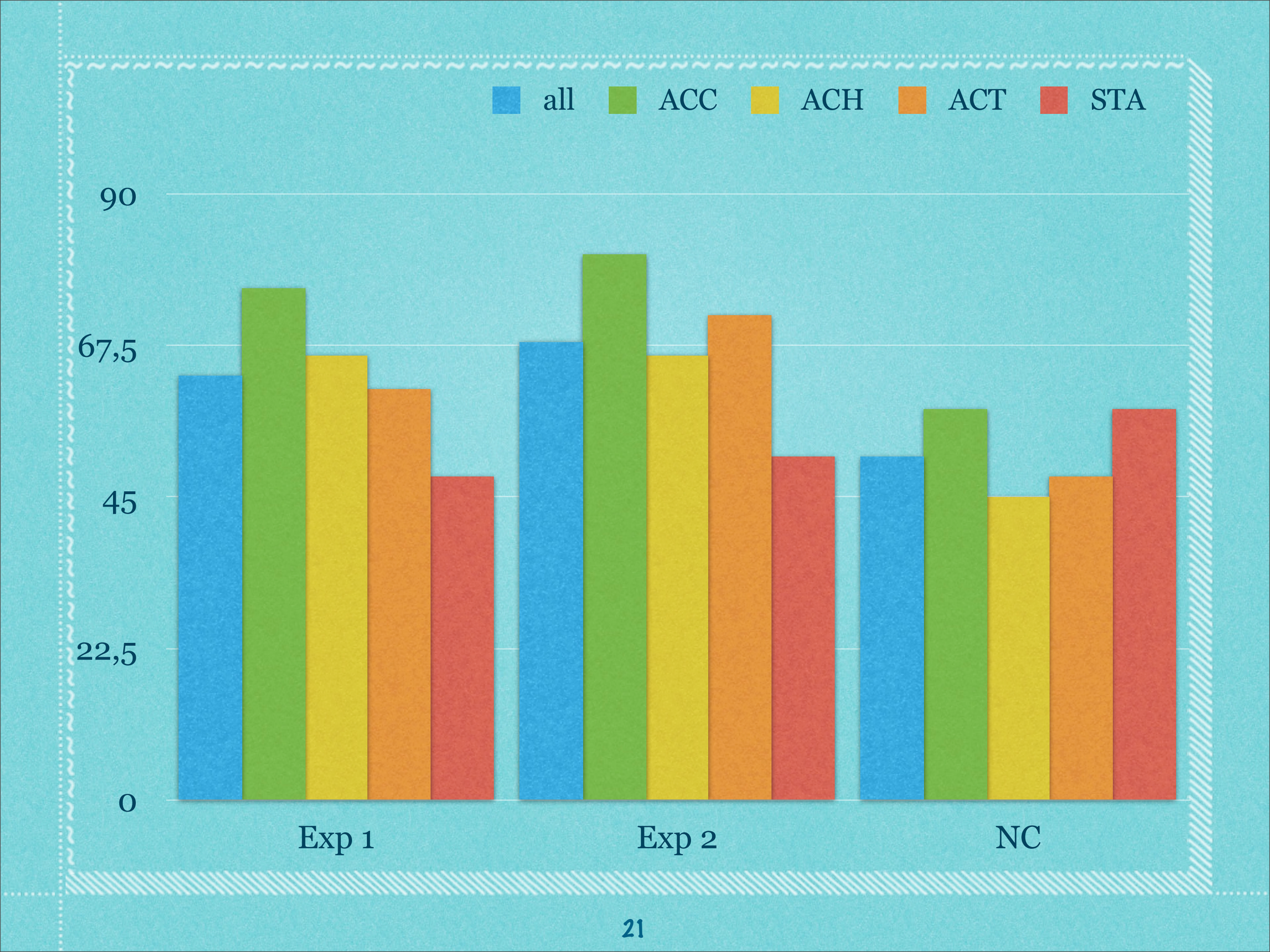
Linguistically-motivated distributional features

adverbial features	-temporal adverbs (e.g. in X time, for X time) -intentional adverbs (e.g. deliberately) -frequency adverbs (e.g. rarely, often) -iterative adverbs (e.g. X times)
morphological features	-present tense -imperfect tense -future tense -simple past -perfect tenses -progressive periphrasis
syntactical and argument structure features	-absence of arguments besides the subj. -presence of direct object, indirect obj. -presence of indirect obj. -presence of a locative argument -presence of a complement sentence -passive diatesis -number, animacy and definiteness of subj. and direct obj.

Corpus-based models vs. behavioral studies

		ACC	ACH	ACT	STA	baseline
IT-verbs	0.63	0.76	0.66	0.61	0.48	
EN-verbs	0.68	0.81	0.66	0.72	0.51	
MaxEnt	0.85	0.89	0.90	0.74	0.78	0.80
NC	0.51	0.58	0.45	0.48	0.58	0.32

- MaxEnt baseline: to every verb occurrence the most frequent ET of the lemma
- NC baseline: to every lemma the most frequent ET in the test set


all
ACC
ACH
ACT
STA
90
67,5
45
22,5
0
Exp 1
Exp 2
NC

IT-V	ACC	ACH	ACT	STA
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ACT	143	62	**531**	141
STA	73	32	138	**224**
P	0.45	0.81	0.66	0.56
R	0.75	0.65	0.61	0.48
F	0.56	0.72	0.63	0.52

IT-P	ACC	ACH	ACT	STA
ACC	**240**	40	78	21
ACH	208	**377**	146	58
ACT	142	28	**393**	233
STA	45	39	67	**86**
P	0.38	0.78	0.57	0.22
R	0.63	0.48	0.49	0.36
F	0.47	0.59	0.53	0.27

MaxEnt	ACC	ACH	ACT	STA
ACC	**733**	41	33	15
ACH	63	**1.166**	10	55
ACT	50	40	**319**	21
STA	30	79	20	**454**
P	0.84	0.88	0.84	0.83
R	0.89	0.90	0.74	0.78
F	0.86	0.89	0.79	0.83

NC	ACC	ACH	ACT	STA
ACC	**14**	2	2	6
ACH	17	**20**	5	2
ACT	10	4	**21**	9
STA	4	0	6	**14**
P	0.31	0.77	0.62	0.45
R	0.58	0.45	0.48	0.58
F	0.41	0.57	0.54	0.51

Corpus-based models

- MaxEnt:
  ACC, ACH easier than ACT, STA (cfr. Exp 1, but not Exp 3)
  difficulties on ACH vs. STA (polysemous items)

- NC:
  performs more evenly across different ETs
  well on ACH vs. STA (opposite ET features)

- All models:
  difficulties on ACC vs. ACH, because they only differ for one feature

characterization of ET as "linguistic objects" strongly related with their corpus distribution

Conclusions

- ET classes ≠ semantic classes
- Cross-modal differences:
  Semantic representations grounded in our sensorimotor perception (Embodied Cognition Framework, Haggard et al. 2007)
  ETs are not a purely linguistic phenomenon but rather they provide us with schemes to interpret reality
- From distributional features to semantic features:
  ET classes which have a clearer distributional characterizations are also easier for the speakers to identify

Future work

- Comparison corpus-based model for English vs. Exp 2 and 4
- Test metalinguistic judgements on small video clips (better depiction of DUR and RES)

Thank you!