An Introduction To Social Signal Processing

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Science of Human Behavior

"[...] the scientific study of human behavior is not the study of how the laws that govern our action came into being, but only how they work [...] the study of how we function is the proper province of social science."

L.McIntyre, "*Dark Ages. The Case for a Science of Human Behavior*", MIT Press, 2006.

Outline

- The Rise of "*Socialism*" in Computing
- Social Signal Processing
- Behavior Observation
- Conclusions

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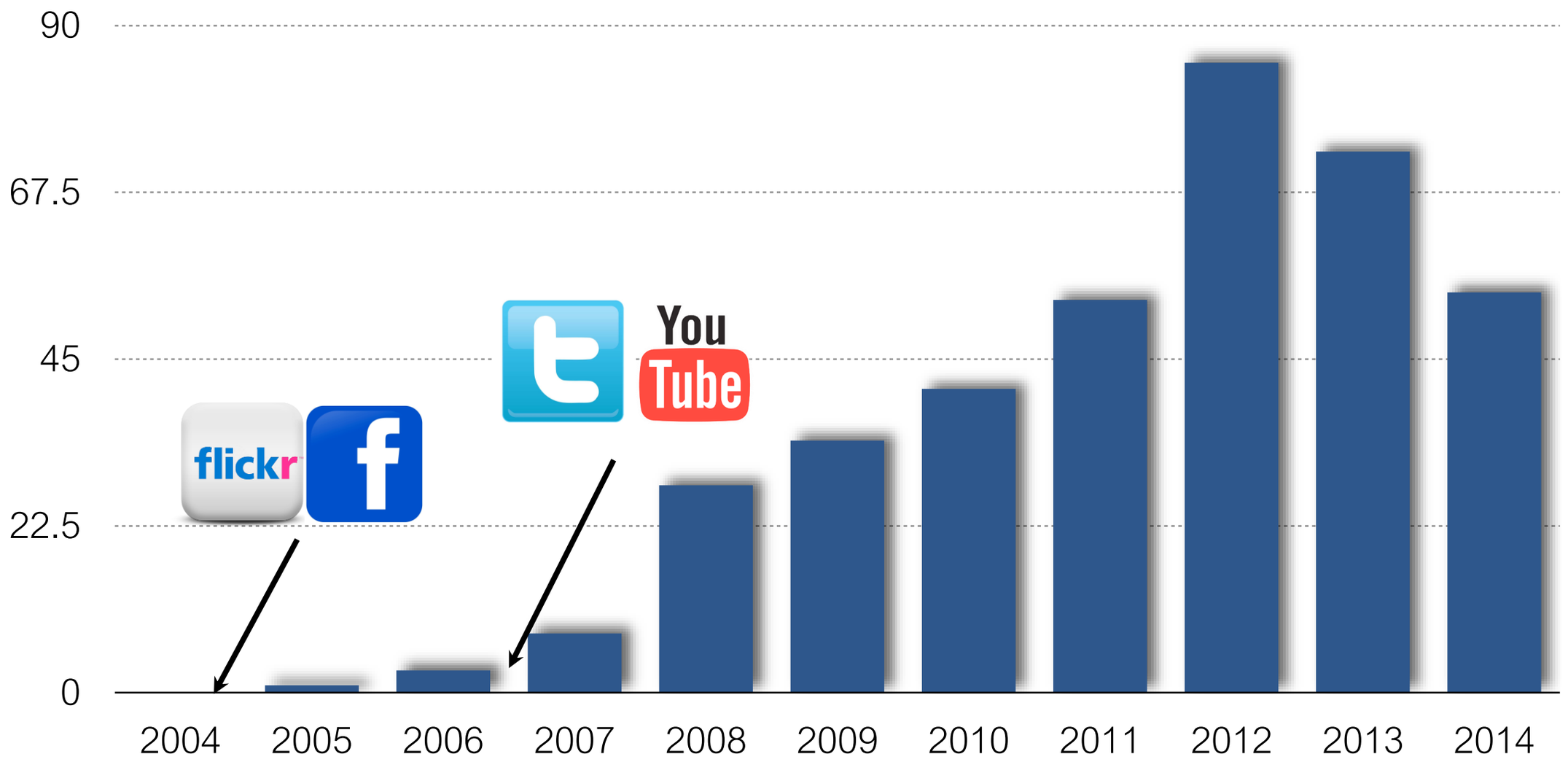
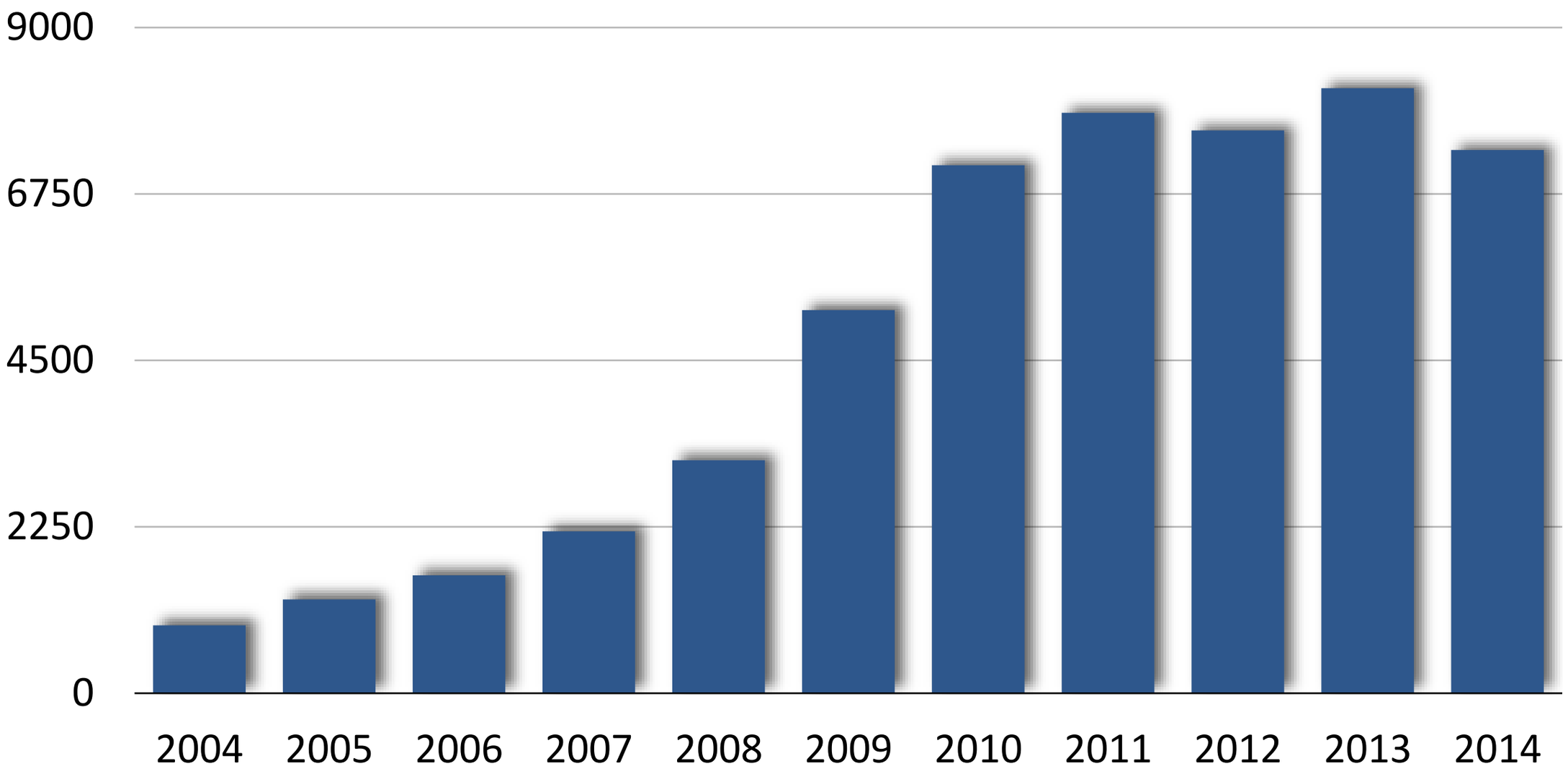
Socialism in Computing (I)



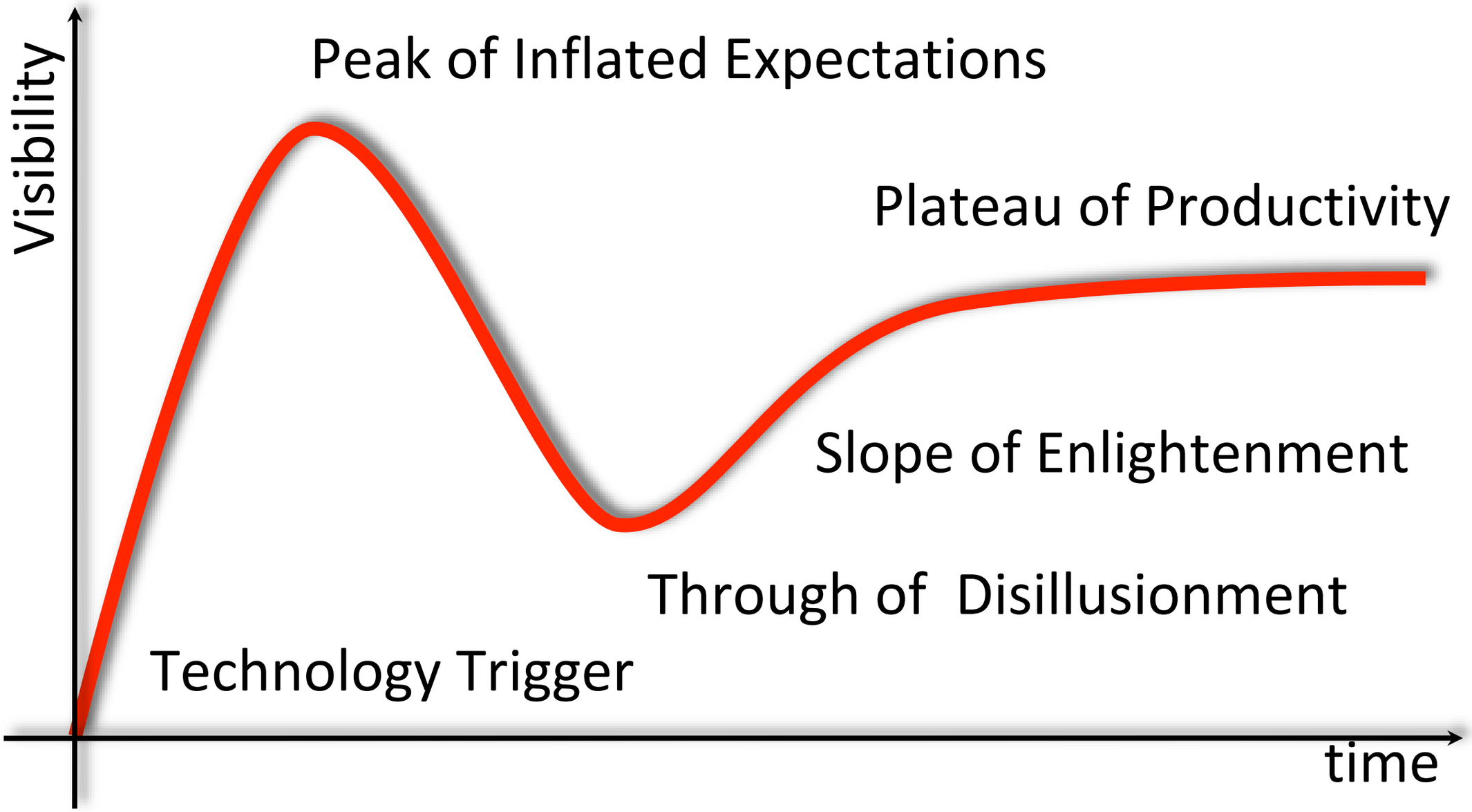
Events showing the word "*social*" in their title (from *dbworld*, a multimedia retrieval mailing list).

Socialism in Computing (II)



Number of papers with the word "*social*" in their title in *IEEEXplore* and *ACM Digital Library*.

The Hype Cycle



Evolution of maturity, adoption and social application of specific technologies (Gartner Group).

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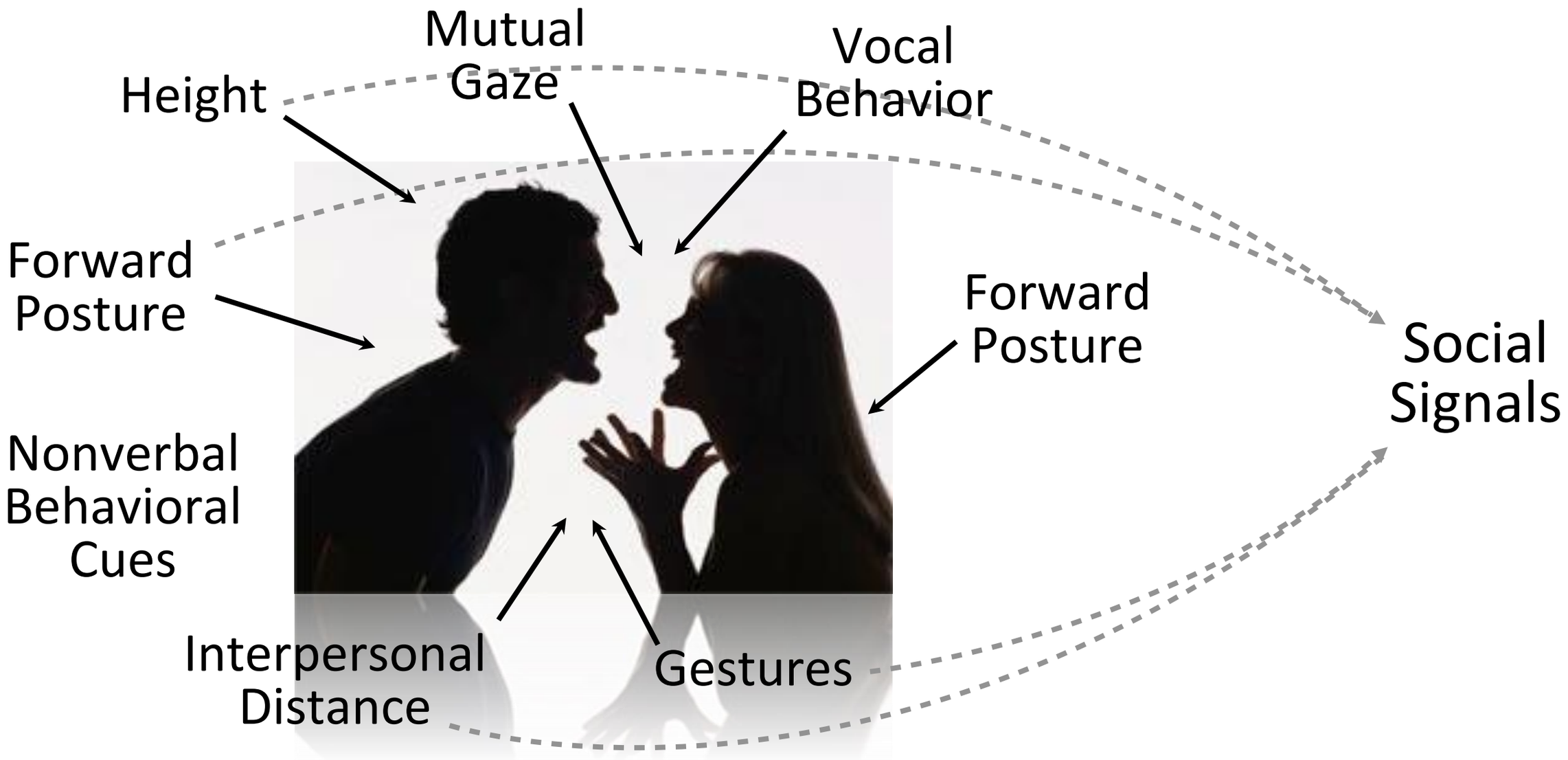
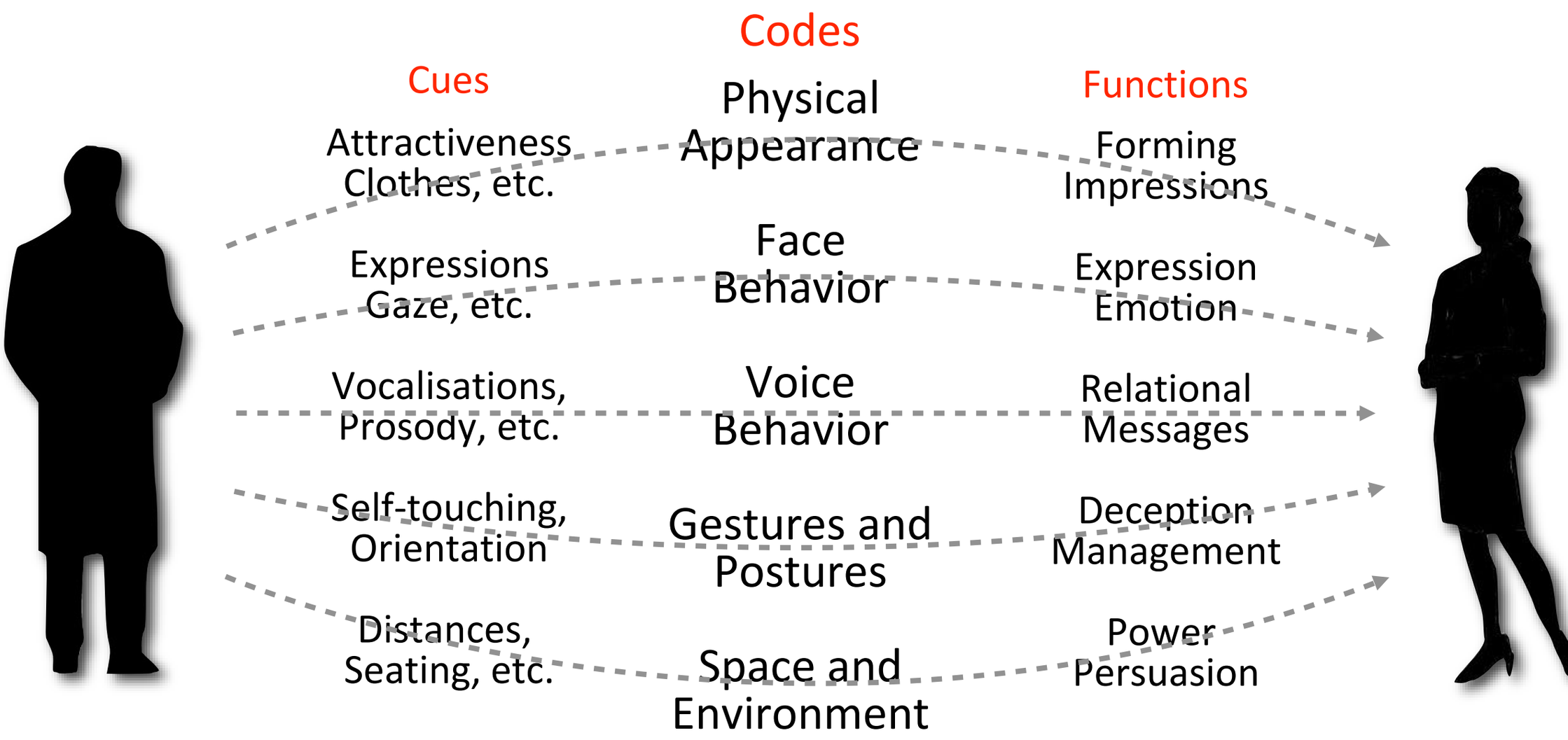
Nonverbal Communication (I)



Vinciarelli, Pantic and Bourlard, "*Social Signal Processing: Survey of an Emerging Domain*", Journal of Image and Vision Computing, 27(12):1743-1759, 2009

Nonverbal Communication (II)



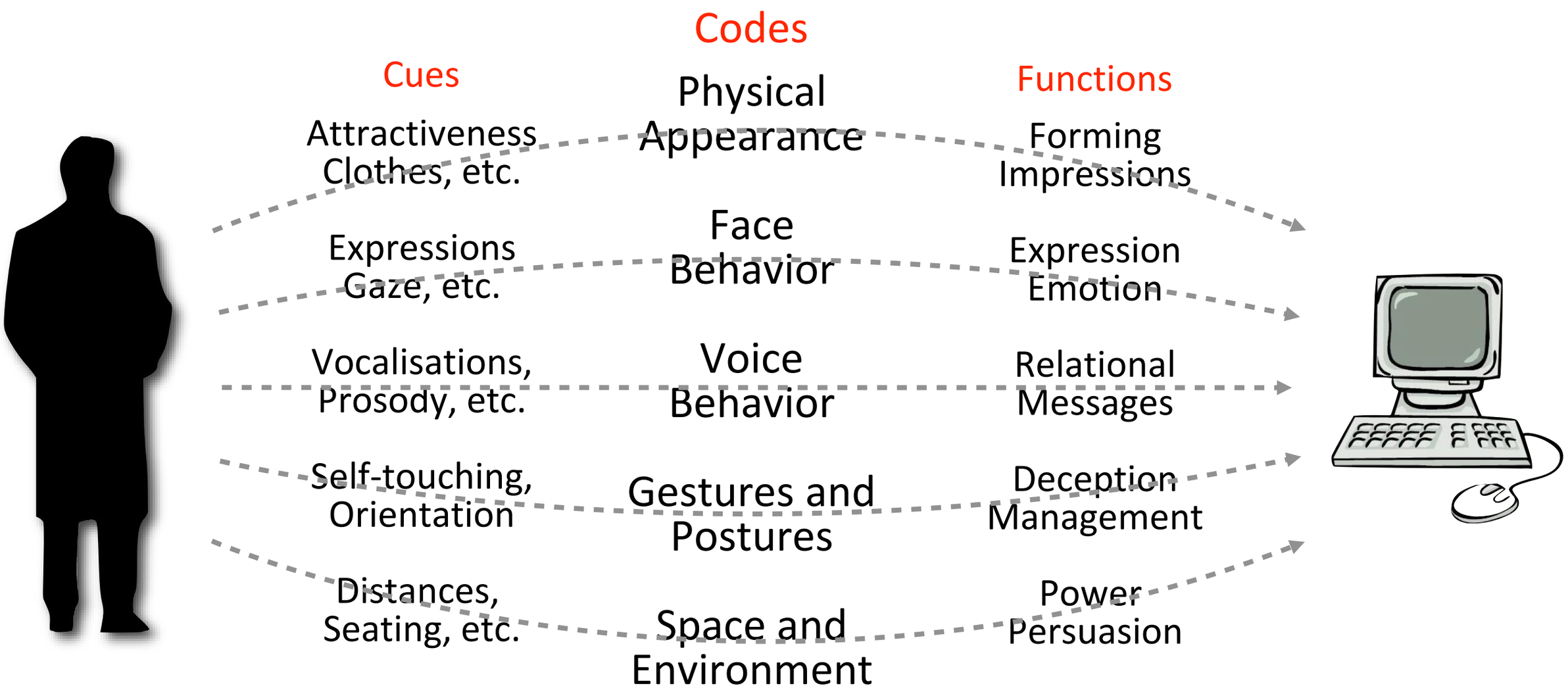
Richmond and McCroskey, "*Nonverbal Behaviors in Interpersonal Relations*", Allyn and Bacon, 1995

SSP: Synthesis

Cues	Codes	Functions
Attractiveness Clothes, etc.	Physical Appearance	Forming Impressions
Expressions Gaze, etc.	Face Behavior	Expression Emotion
Vocalisations, Prosody, etc.	Voice Behavior	Relational Messages
Self-touching, Orientation	Gestures and Postures	Deception Management
Distances, Seating, etc.	Space and Environment	Power Persuasion

Vinciarelli, Pantic, Heylen, Pelachaud, Poggi, D'Errico, Schroeder, "*Bridiging the Gap Between Social Animal and Unsocial Machine: A Survey of SSP*", IEEE Transactions on Affective Computing, 3(1):69-87,2012

SSP: Analysis



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Social Signals

"[…] acts or structures that influence the behavior or internal state of other individuals."

Mehu and Scherer, Cognitive Processing, 2012

"communicative or informative signals which […] provide information about social facts"

Poggi and D'Errico, Cognitive Processing, 2012

"actions whose function is to bring about some reaction or to engage in some process"

Brunet and Cowie, J. of Multimodal User Interfaces, 2012

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Social Signal Processing

SSP studies signals [...] that

- are produced during social interactions;
- that either play a part in the formation and adjustment of relationships and interactions between agents (human and artificial)
- or provide information about the agents;
- and that can be addressed by technologies of signal processing and synthesis.

The ``*Belfast Declaration*'': http://sspnet.eu/about/

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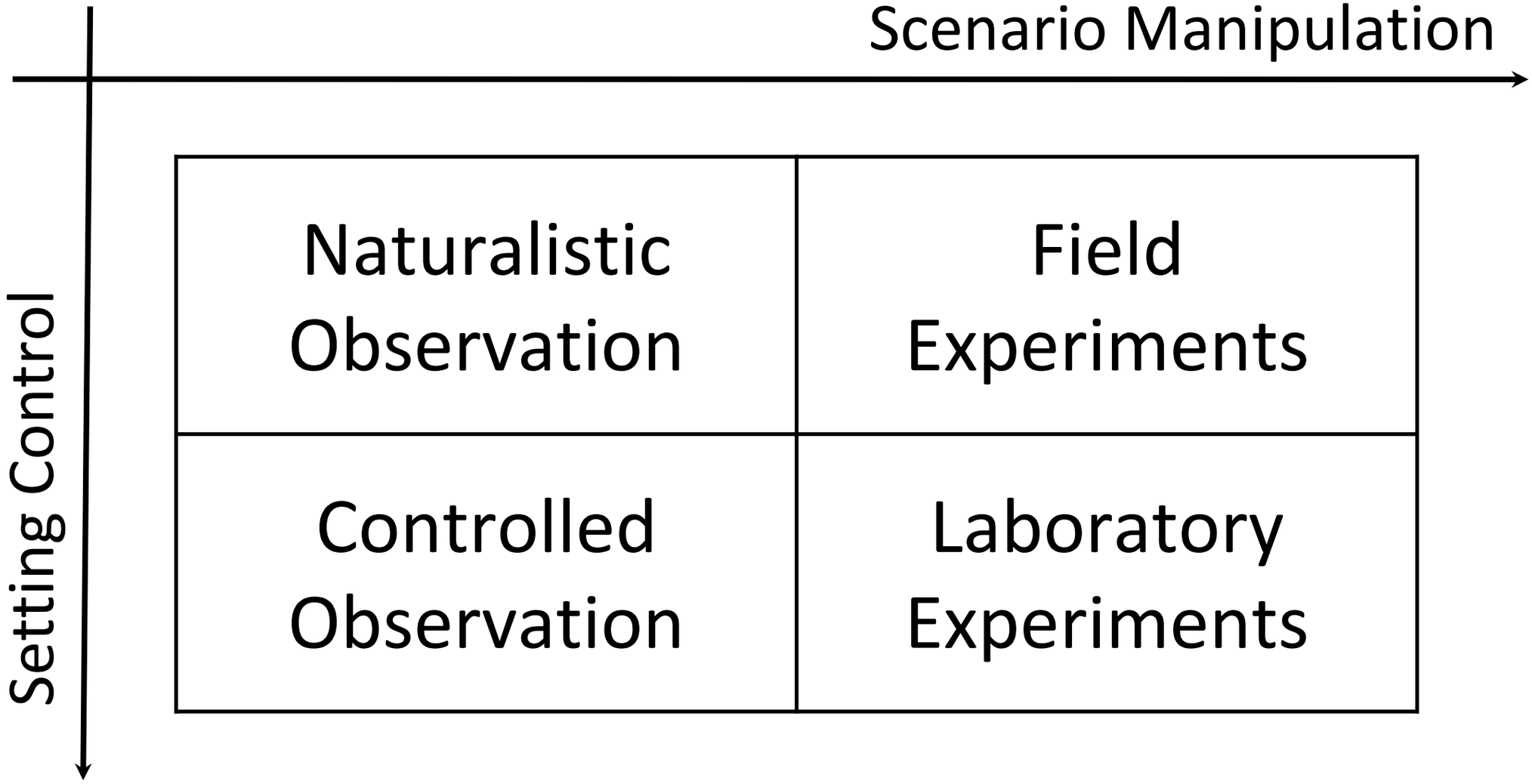
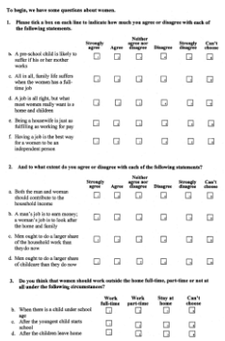
Experimental Setup



Hecht, Guerrero, "*Perspectives on Nonverbal Research Methods*", in "The Nonverbal Communication Reader", Guerrero, De Vito, Hecht (Eds.), pp. 24-28, 1999.

Corpus Collection



To begin, we have some questions about women.

1. Please tick a box on each line to indicate how much you agree or disagree with each of the following statements.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Can't choose
a. A pre-school child is likely to suffer if his or her mother works	☐	☐	☐	☐	☐	☐
c. All in all, family life suffers when the women has a full-time job	☐	☐	☐	☐	☐	☐
d. A job is all right, but what most women really want is a home and children	☐	☐	☐	☐	☐	☐
e. Being a housewife is just as fulfilling as working for pay	☐	☐	☐	☐	☐	☐
f. Having a job is the best way for a woman to be an independent person	☐	☐	☐	☐	☐	☐

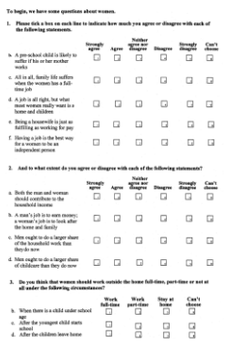
2. And to what extent do you agree or disagree with each of the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Can't choose
a. Both the man and woman should contribute to the household income	☐	☐	☐	☐	☐	☐
b. A man's job is to earn money; a woman's job is to look after the home and family	☐	☐	☐	☐	☐	☐
c. Men ought to do a larger share of the household work than they do now	☐	☐	☐	☐	☐	☐
d. Men ought to do a larger share of childcare than they do now	☐	☐	☐	☐	☐	☐

3. Do you think that women should work outside the home full-time, part-time or not at all under the following circumstances?

	Work full-time	Work part-time	Stay at home	Can't choose
b. When there is a child under school age	☐	☐	☐	☐
c. After the youngest child starts school	☐	☐	☐	☐
d. After the children leave home	☐	☐	☐	☐

Psychometric Questionnaires



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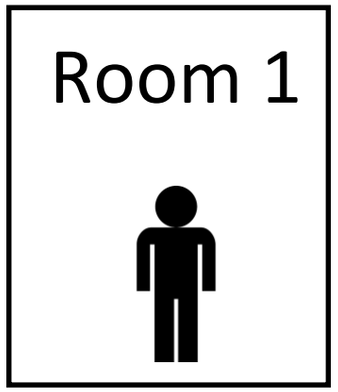
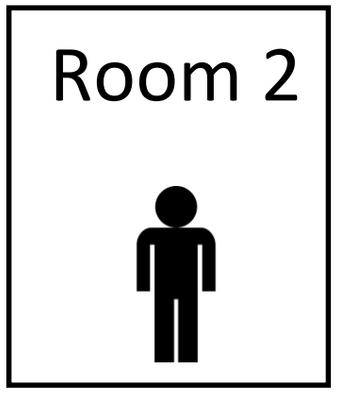
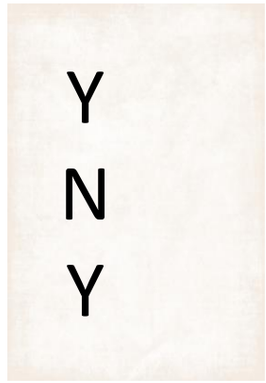
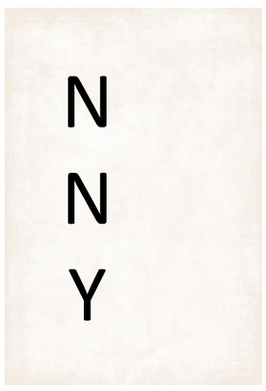




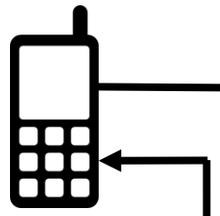
Step 1



Individual Solutions



Step 2



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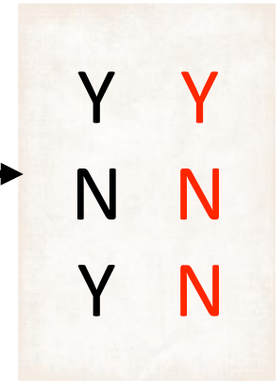
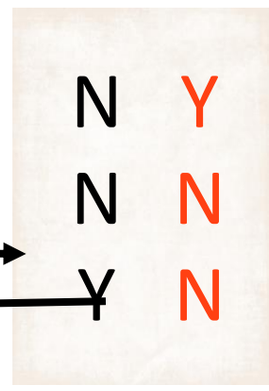


Negotiated Solution



Step 4

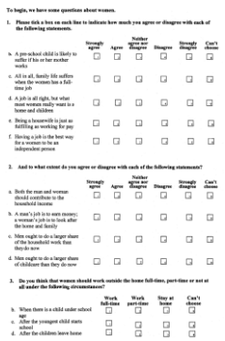
The Winter Survival Task (WST)

Your opinion (fill this column BEFORE the call)		Items		Consensus (fill this column DURING the call)
	1.	A ball of steel wool		
	2.	A small axe		
	3.	A loaded 45-caliber pistol		
	4.	Can of butter		
	5.	Newspapers (one per person)		
	6.	Cigarette lighter (without fluid)		
	7.	Extra shirt and trousers for each survivor		
	8.	6m x 6m (≈20 ft x 20 ft) piece of heavy-duty canvas		
	9.	A sectional air map made of plastic		
	10.	750 ml of whisky		
	11.	A compass		
	12.	Family-size chocolate bars (one per person)		

The participants are asked to pick the items that increase the chances of survival in a polar environment after a plane crash.

A.Vinciarelli, H.Salamin, A.Polychroniou, "*Negotiating Over Mobile Phones: Calling or Being Called can Make the Difference*", Cognitive Computation, 6(4):77-688, 2014.

Corpus Collection



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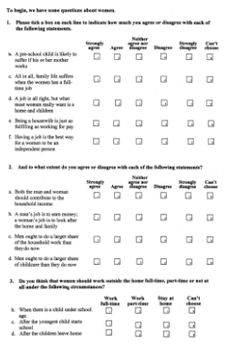

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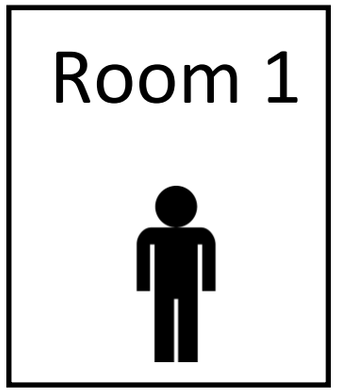

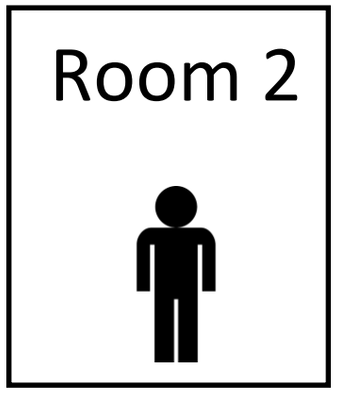

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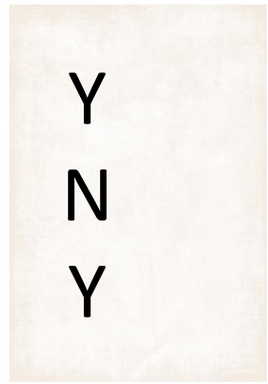

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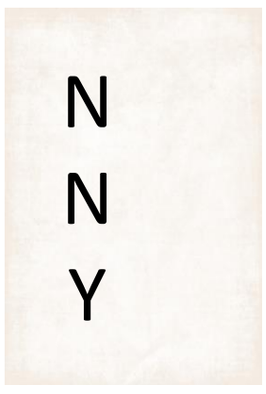
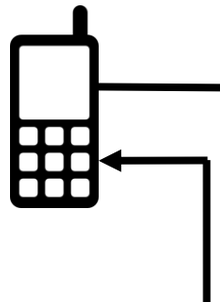


Step 2



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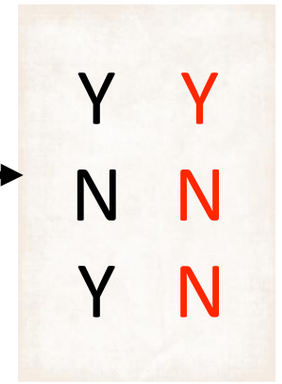

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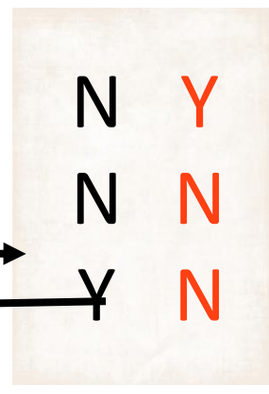


Step 4

The SSPNet Mobile Corpus

Number of Calls	60
Number of Subjects	120
Total Length	11h : 48m : 24s
Average Length	11m : 48s
Audio Sampling Frequency	44kHz
Gyroscopes Sampling Frequency	68Hz
Psychometric Questionnaires	2
Total Annotated Cues	16,235

A.Vinciarelli, P.Chatziioannou, A.Esposito,"*When Words are Not Everything: the use of laughter, fillers, back-channel, silence, and overlapping speech in phone calls*",
Frontiers in ICT, 2(4), 2015.

Laughter

"[Laughter is] a common, species-typical human vocal act and auditory signal that is important in social discourse."

R.Provine, Y.Yong, "*Laughter: A stereotyped human vocalization*", Ethology, 89(2):115–124, 1991

Fillers

“[Fillers are expressions like “ehm” and “uhm” that] are characteristically associated with planning problems [...] planned for, formulated, and produced as parts of utterances just as any word is.”

H.H.Clark and J.E.Fox Tree, “*Using “uh” and “um” in spontaneous speaking*”, Cognition, 84(1):73–111, 2002

Back-Channel

“short utterances produced by one participant in a conversation while the other is talking.”

N.Ward and W.Tsukahara, “*Prosodic features which cue back-channel responses in English and Japanese*”, Journal of Pragmatics, 32(8):1177–1207, 2000

Silence

“the main common link between speech and silence is that the same interpretive processes apply to someone’s remaining meaningfully silent in discourse as to their speaking.”

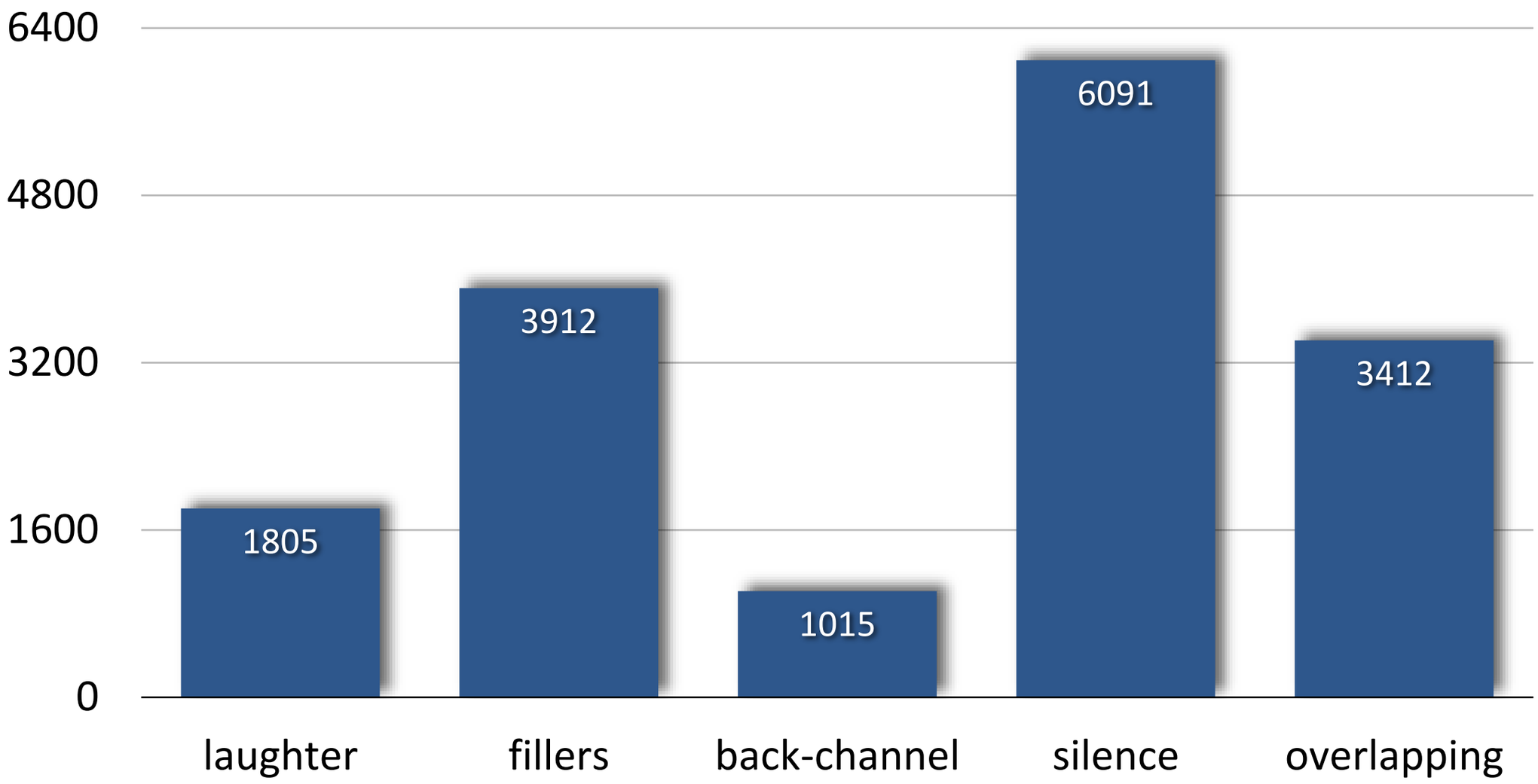
A.Jaworski, “*The power of silence in communication*”, in L. Guerrero, J. De Vito, and M. Hecht, eds., “*The nonverbal communication reader*”, Waveland Press, 156–162, 1999

Overlapping Speech

"Talk by more than one person at a time in the same conversation is one of the two major departures that occur from what appears to be a basic design feature of conversation, [...] namely 'one at a time' [...]."

E.Schegloff, "*Overlapping talk and the organization of turn-taking for conversation*", Language in Society, 29(01):1–63, 2000

Frequency Distribution



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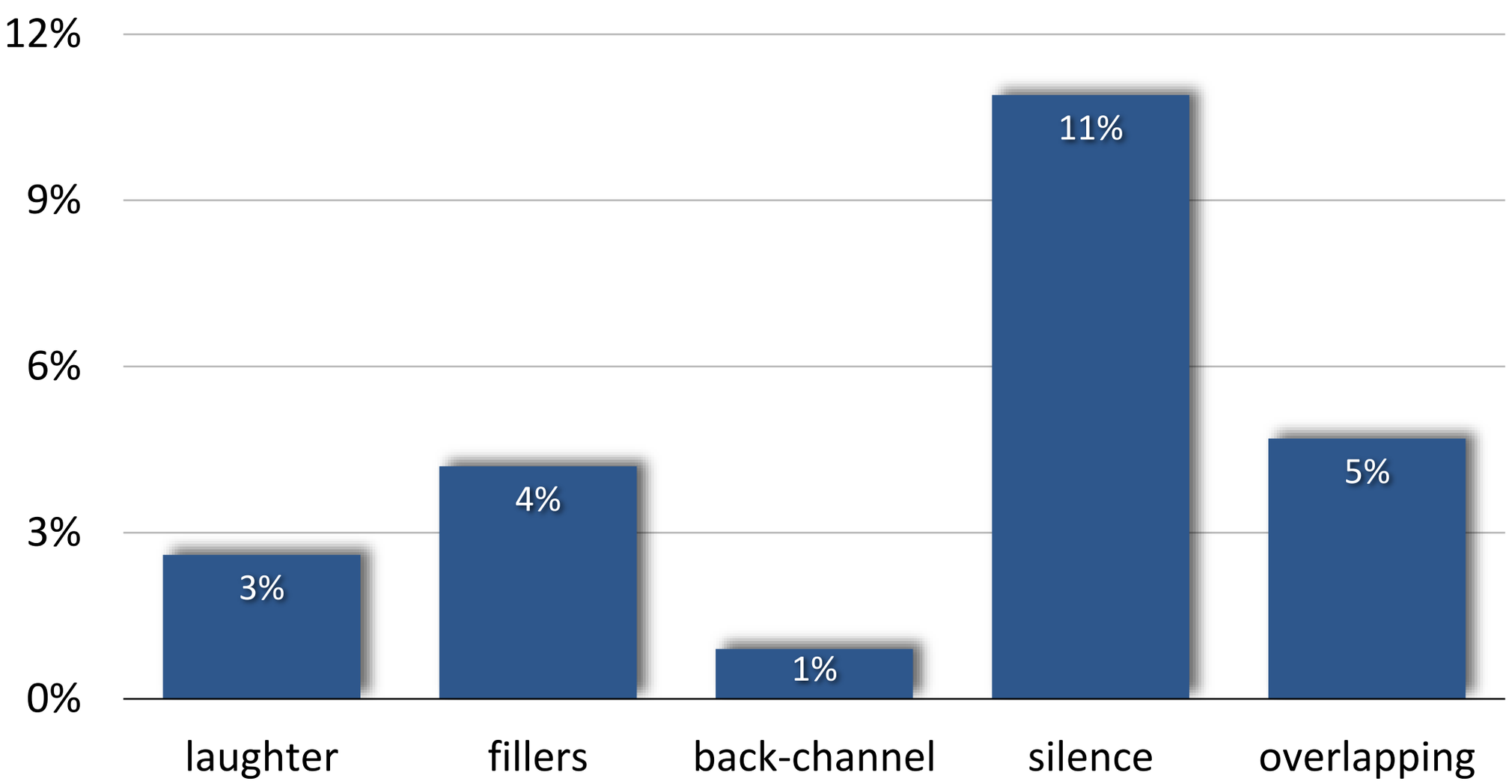
Time Distribution



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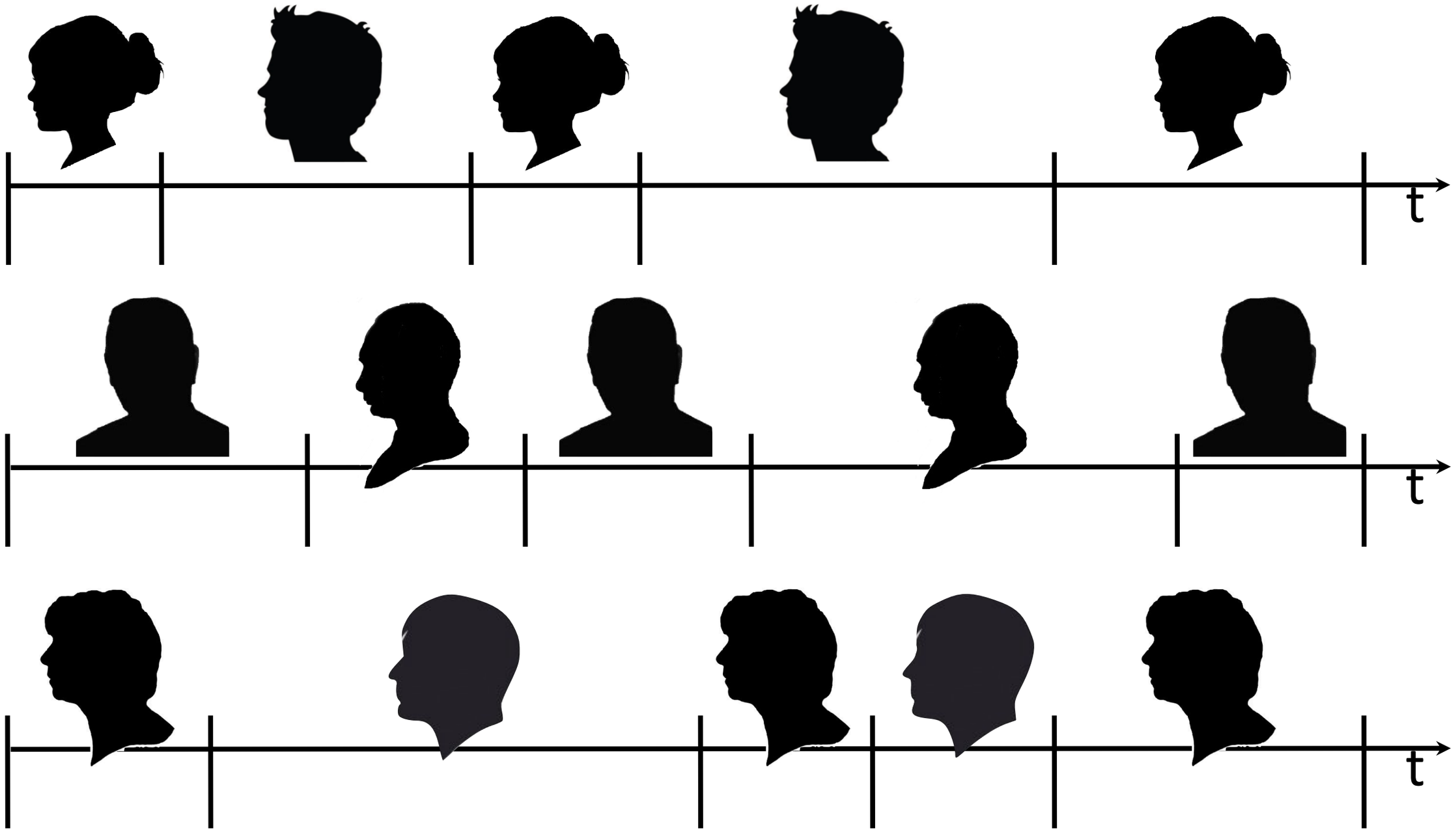
Measuring Behavior

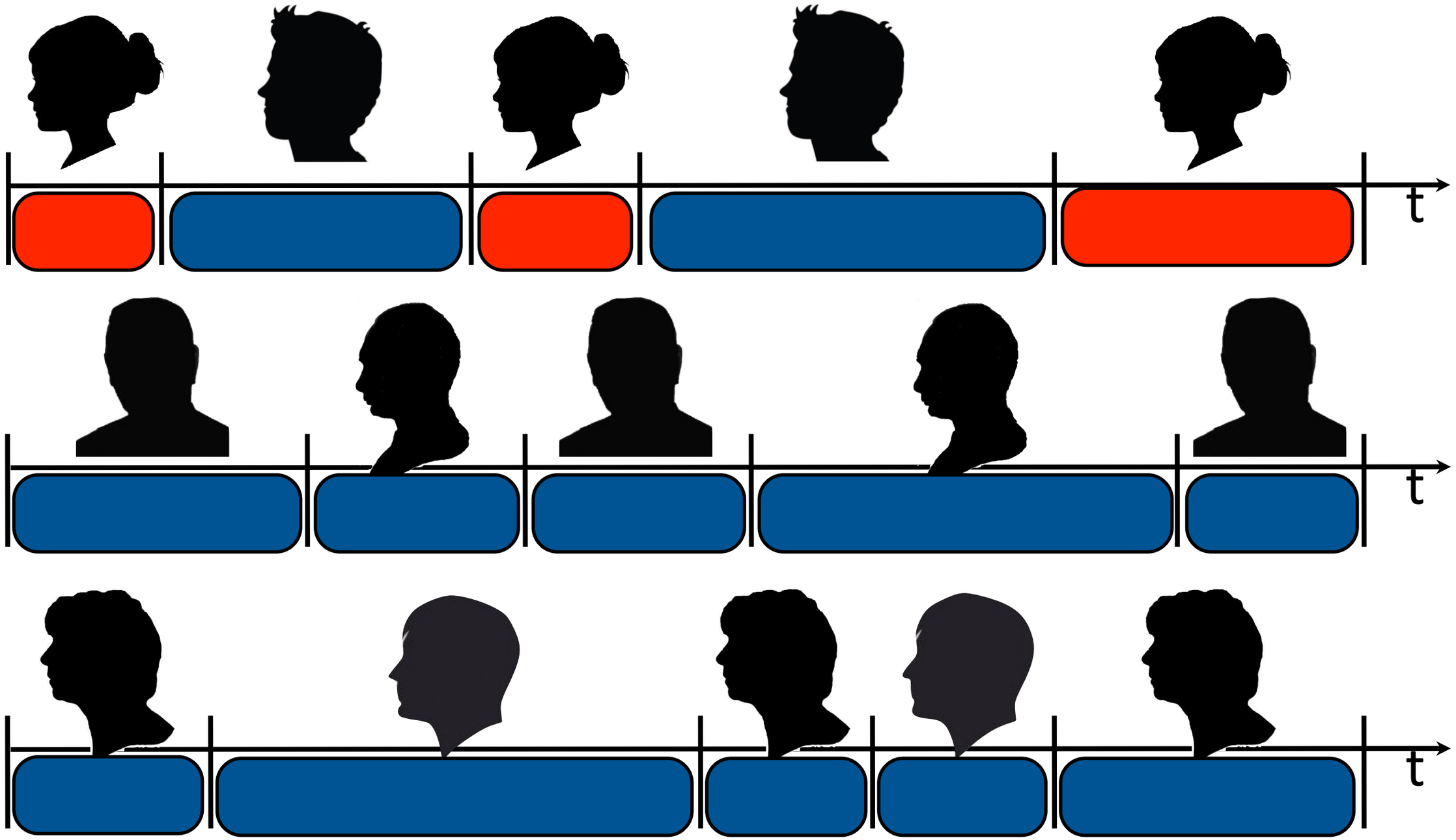
"[…] the circumstances in which an activity is performed and those in which it never occurs [provide] clues as to what the behavior pattern might be for (its function)."

P.Martin, P.Bateson, "*Measuring Behavior*", Cambridge University Press, 2007

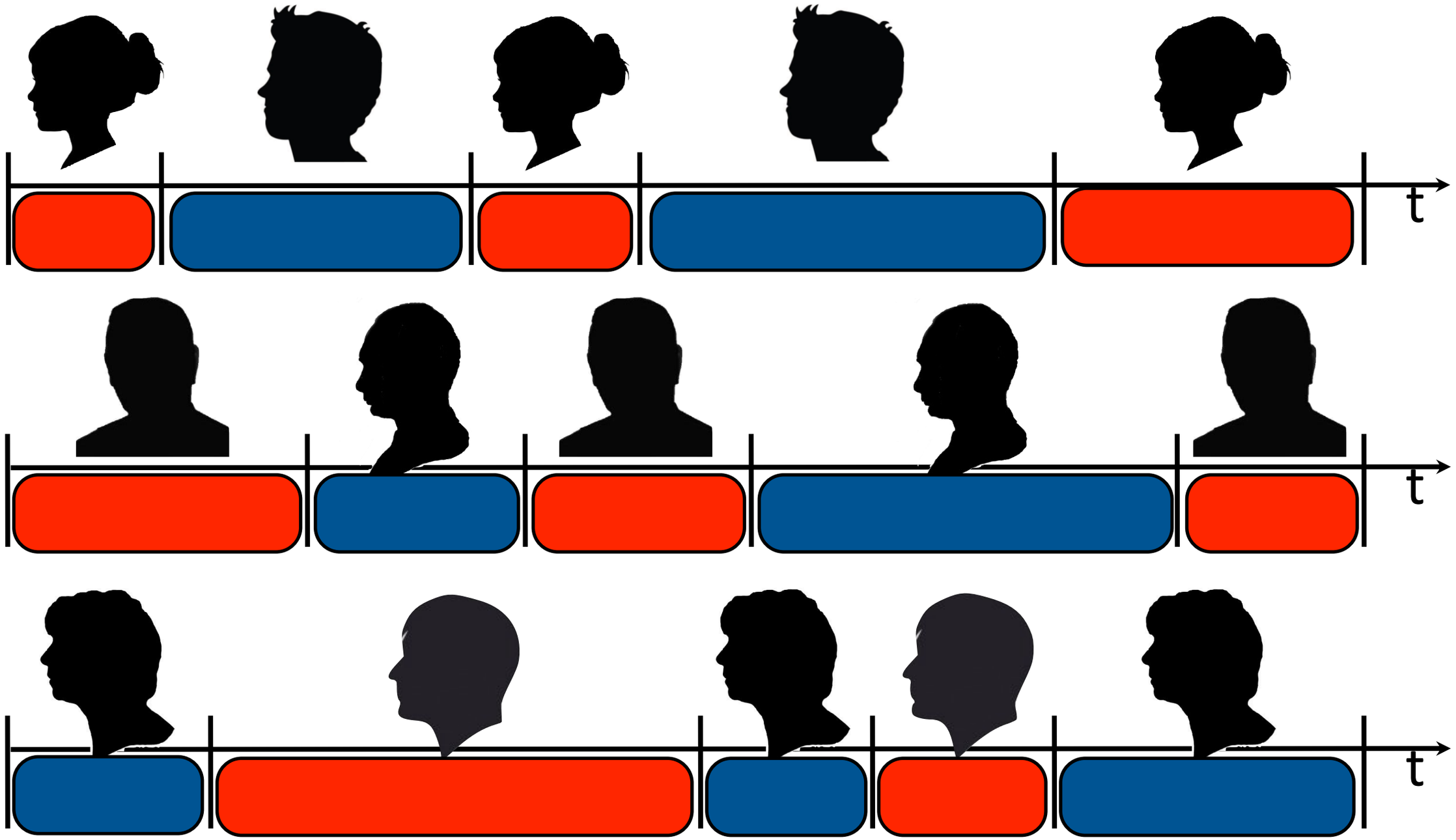
Splitting The Corpus



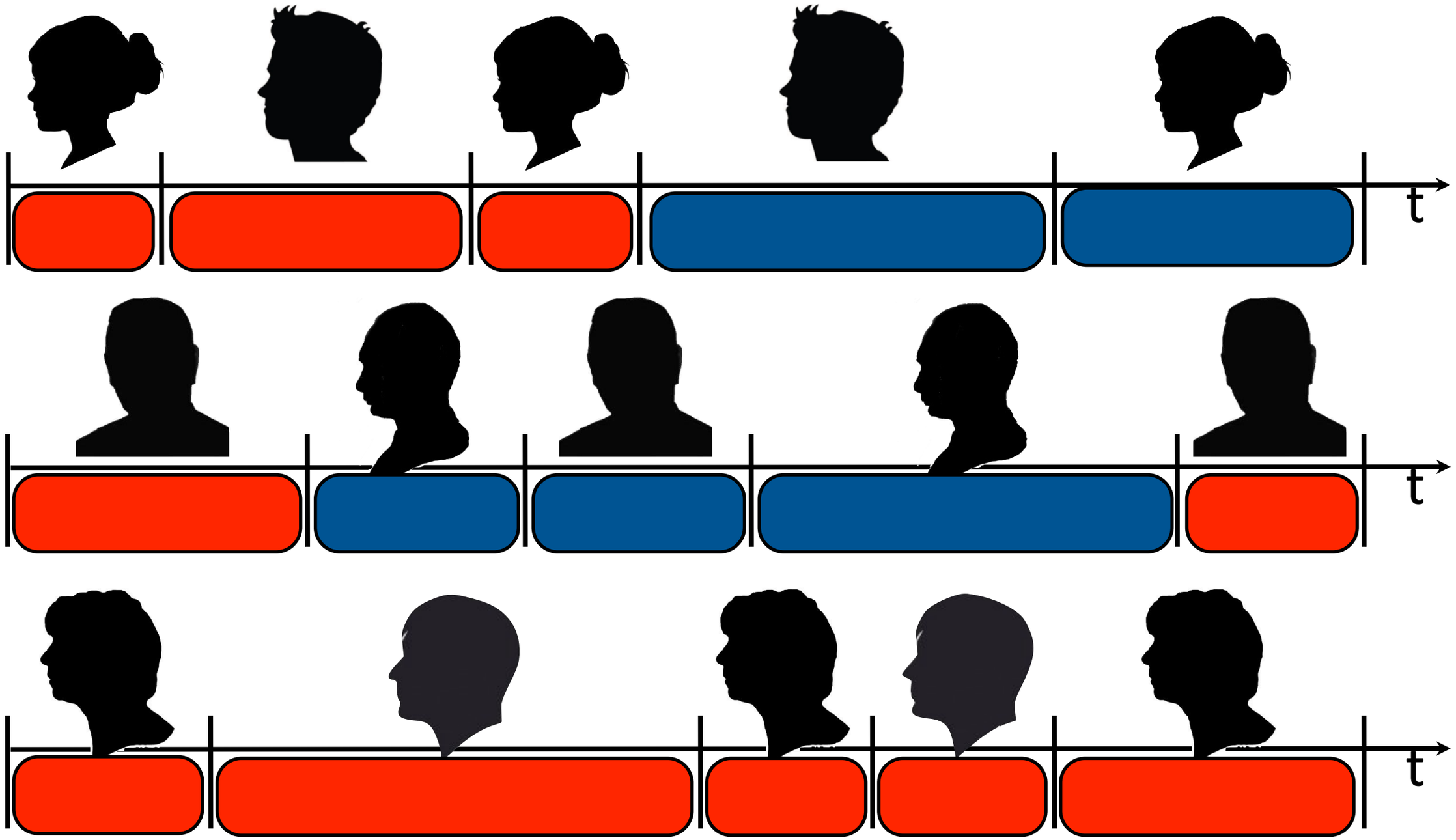
Splitting The Corpus (Gender)



Splitting The Corpus (Role)



Splitting The Corpus (Mode)



Measuring Deviations (I)

$$v \in V = \{v_1, v_2, \ldots, v_L\}$$

$$0 < p_k < 1 \qquad \sum_{k=1}^{L} p_k = 1$$

$$E_k = N \cdot p_k$$

- Each value of the variable accounts for a fraction of the total corpus time;
- If the cues are uniformly distributed, occurrences are expected to be proportional to the fraction.

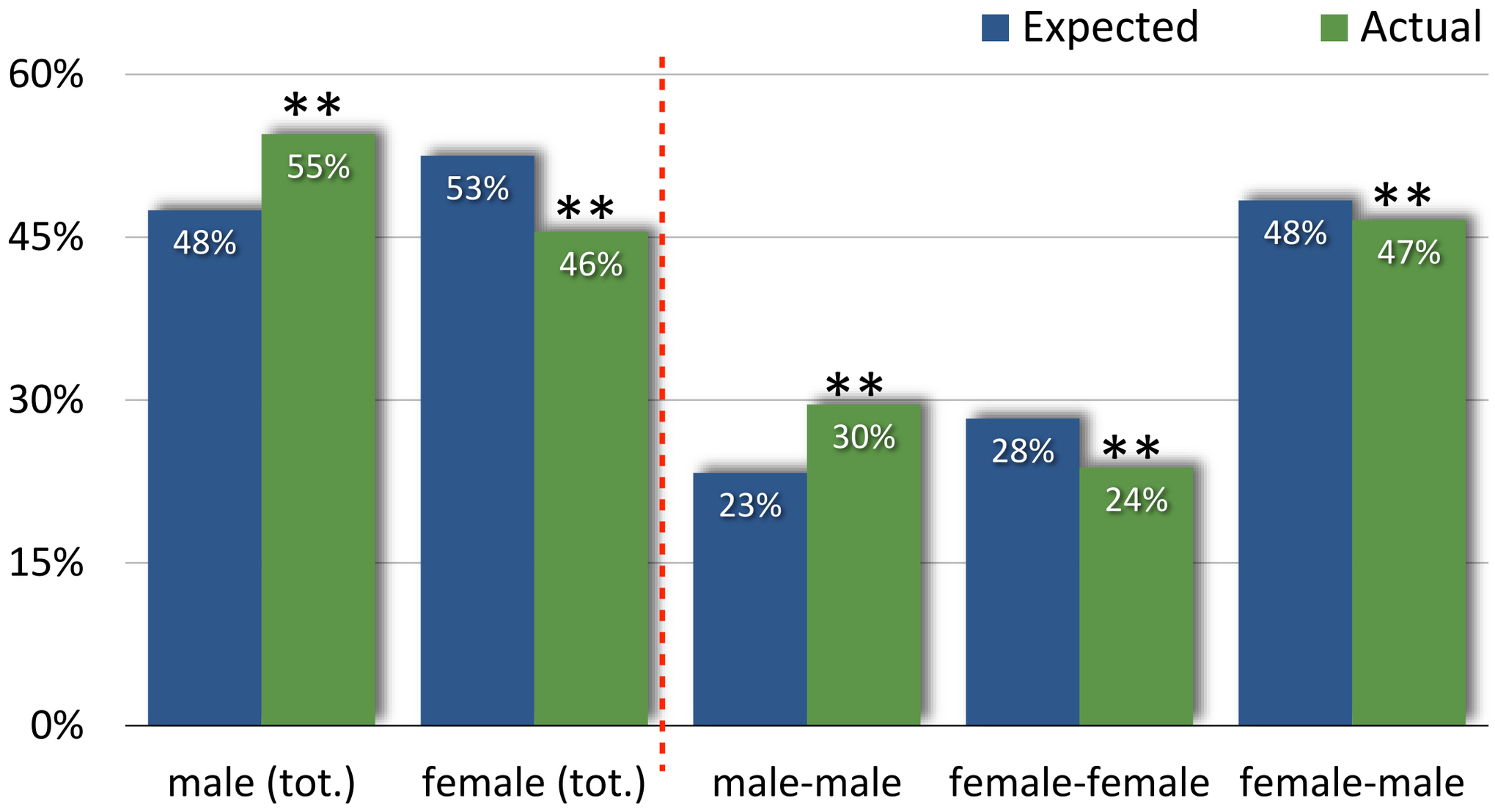
Measuring Deviations (II)

$$\chi^2 = \frac{(E_k - O_k)^2}{E_k}$$

$$p(\chi^2) < 0.01$$

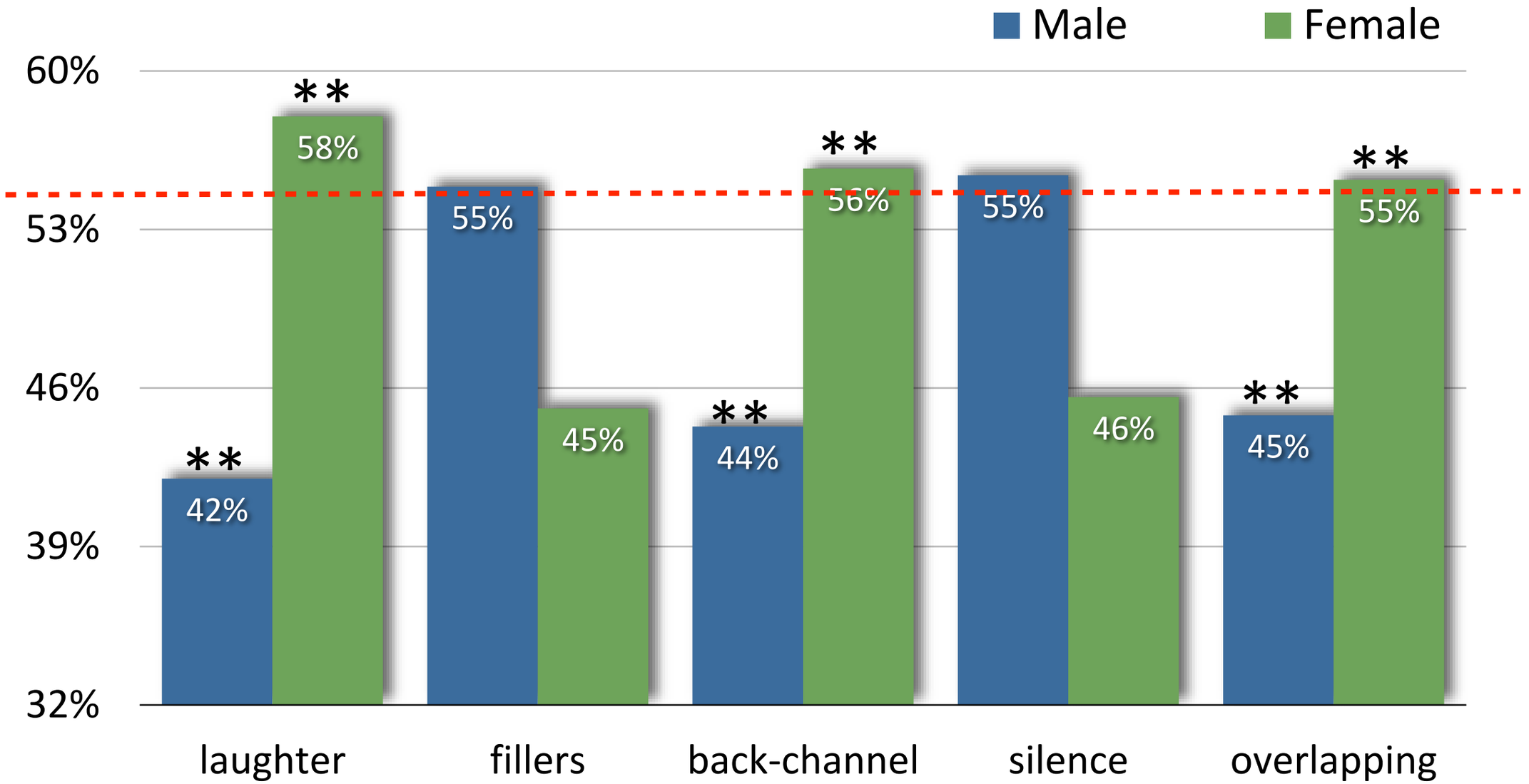
- The observed number of occurrences is the one actually counted in an interval;
- The test estimates the probability of observing O occurrences if these are distributed uniformly.

Gender Differences (Time)



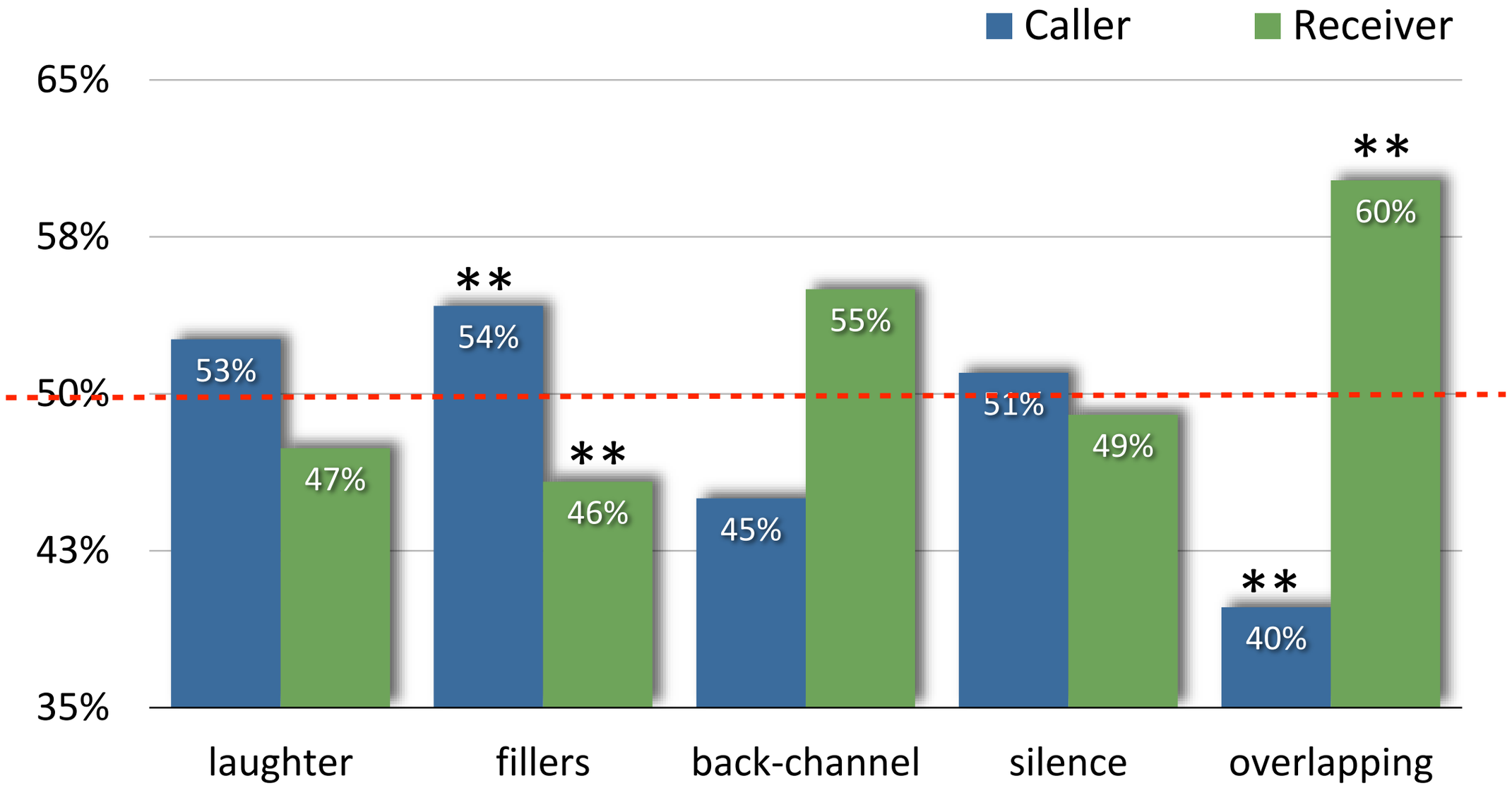
- On average, male subjects speak longer than female ones;
- Average duration: male-male 899 s, female-male 639 s, female-female 595 s.

Gender Differences (Cues)



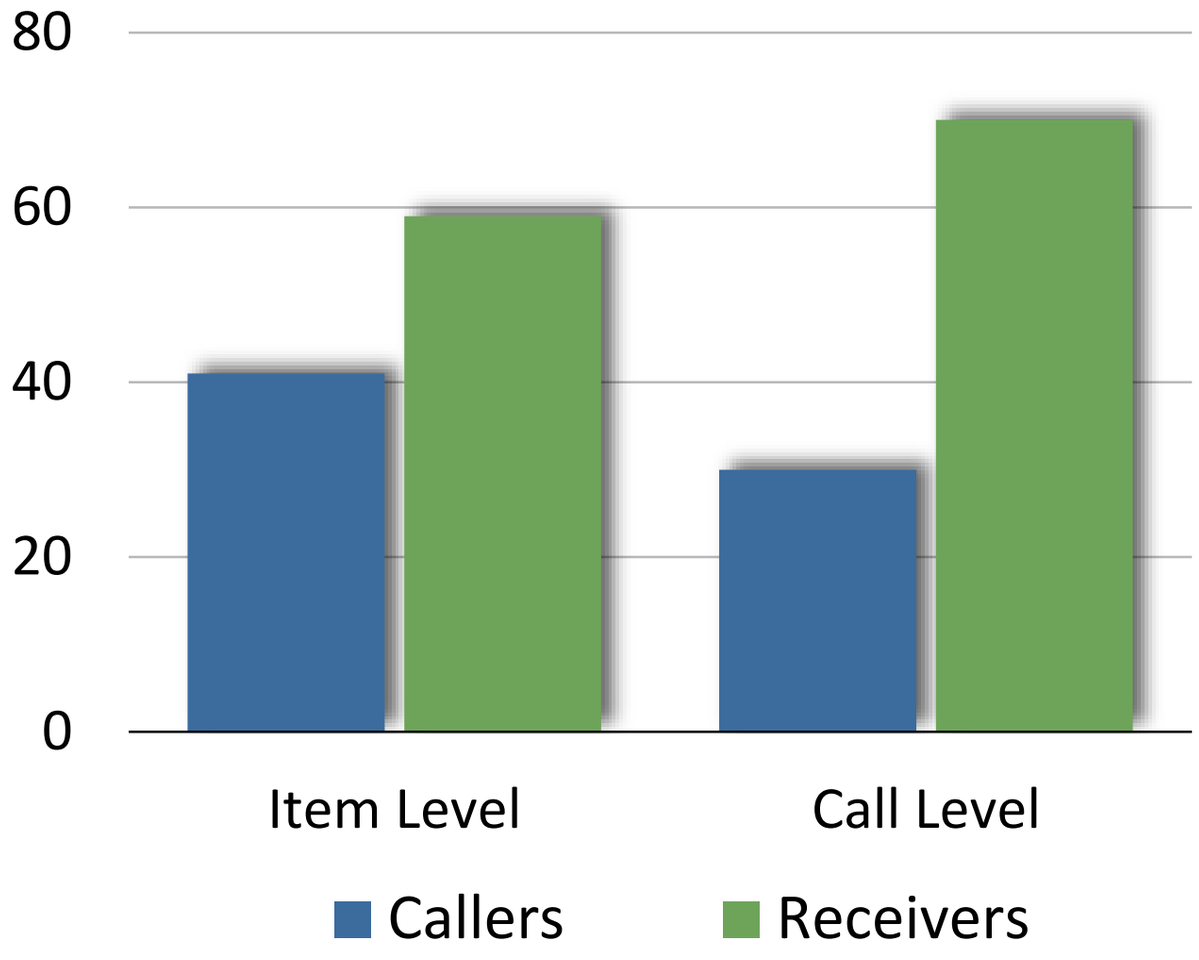
- Female subjects tend to laugh, support and interrupt more;
- Observations compatible with stereotypes and stereotype-threat effects.

Role Differences (Cues)



- Receivers tend to display less fillers and to interrupt more;
- Observations compatible with higher dominance and social verticality.

Negotiating on the Phone

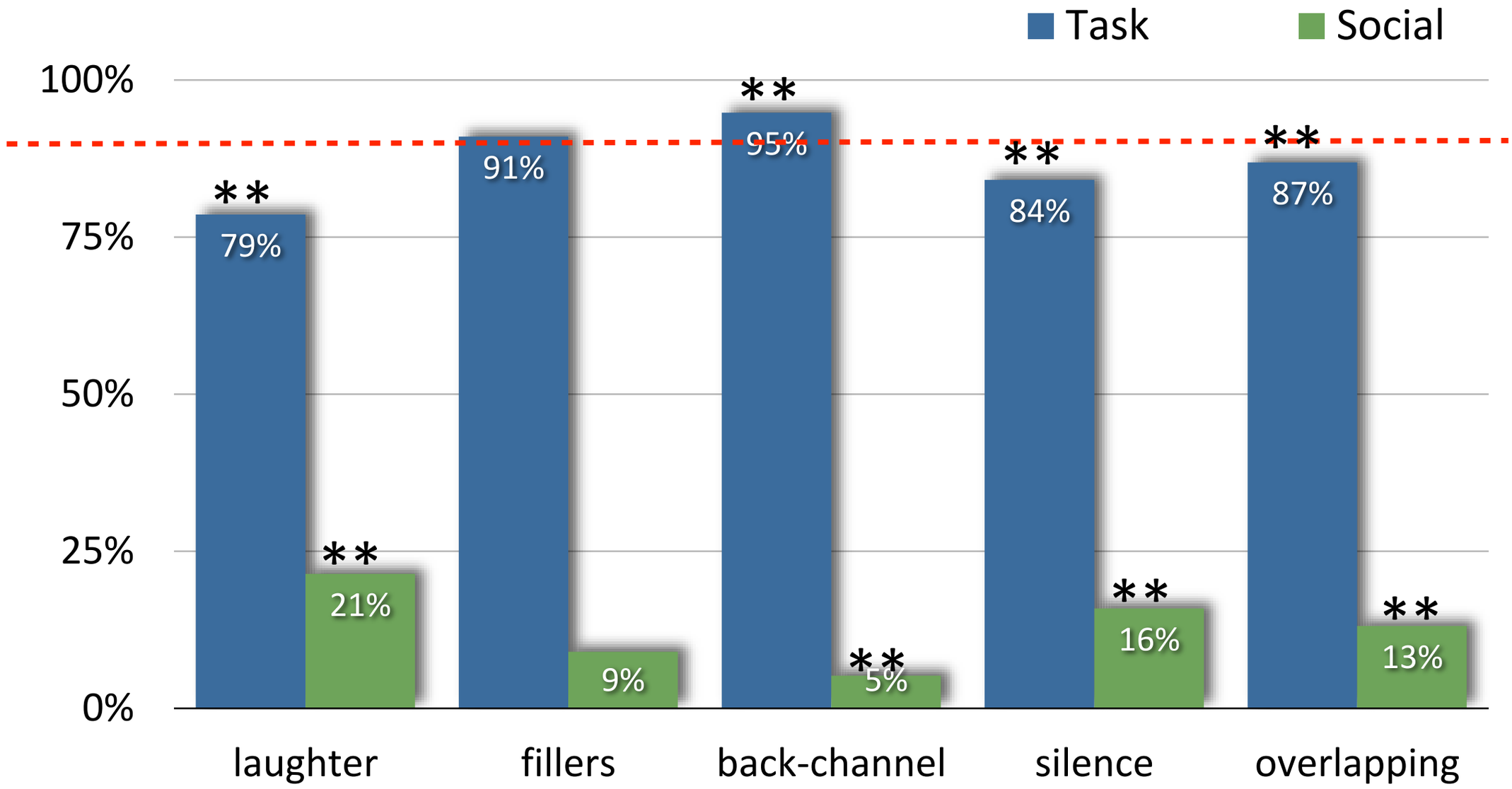


Receivers win against callers in 59% of the negotiations (70% of the times at the call level).

Calling or receiving makes the difference ($p<0.005$).

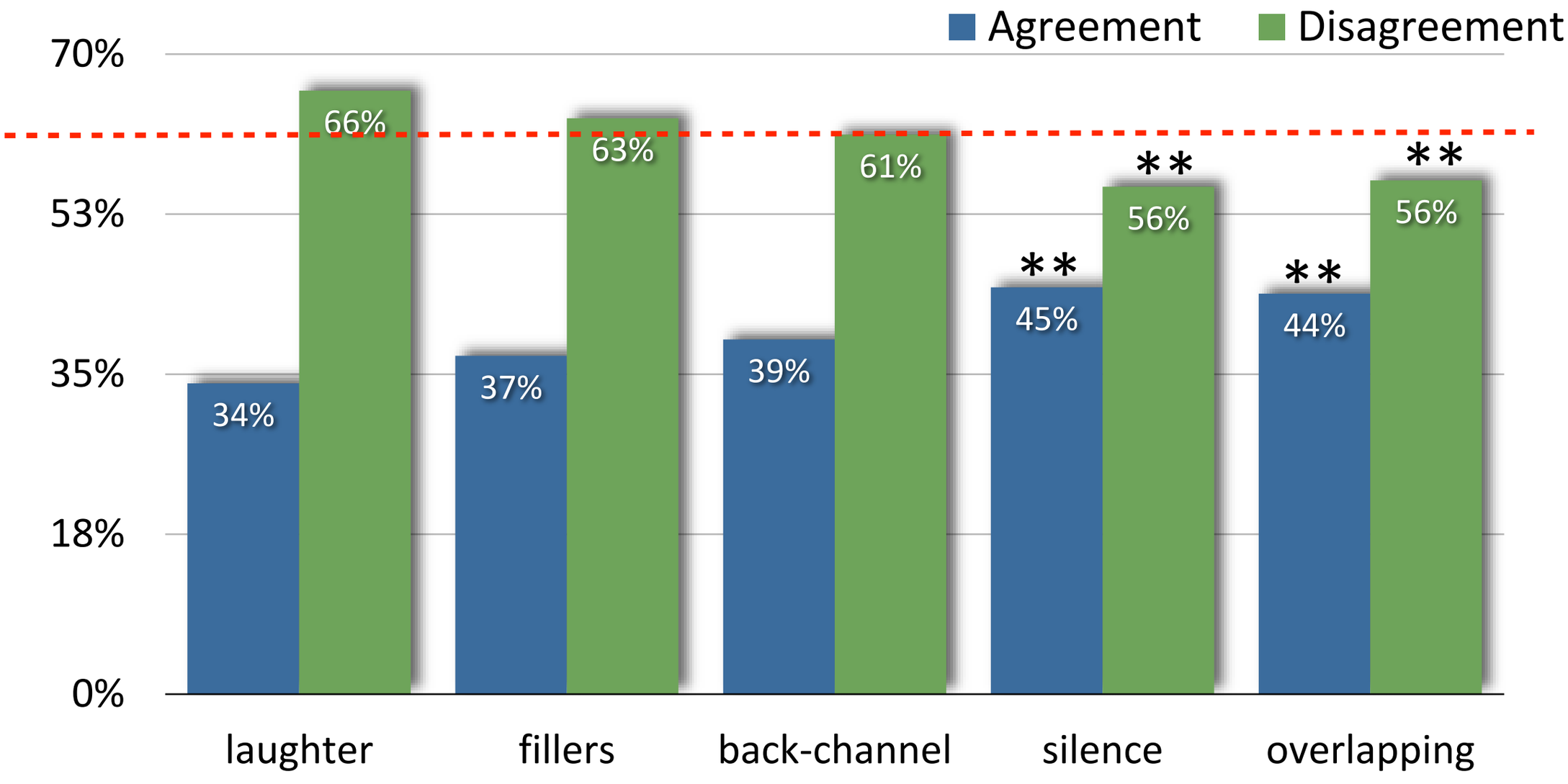
A.Vinciarelli, H.Salamin, A.Polychroniou, "*Negotiating Over Mobile Phones: Calling or Being Called can Make the Difference*", Cognitive Computation, Vol. 6, no. 4, pp. 77-688, 2014.

Topic Differences (Cues)



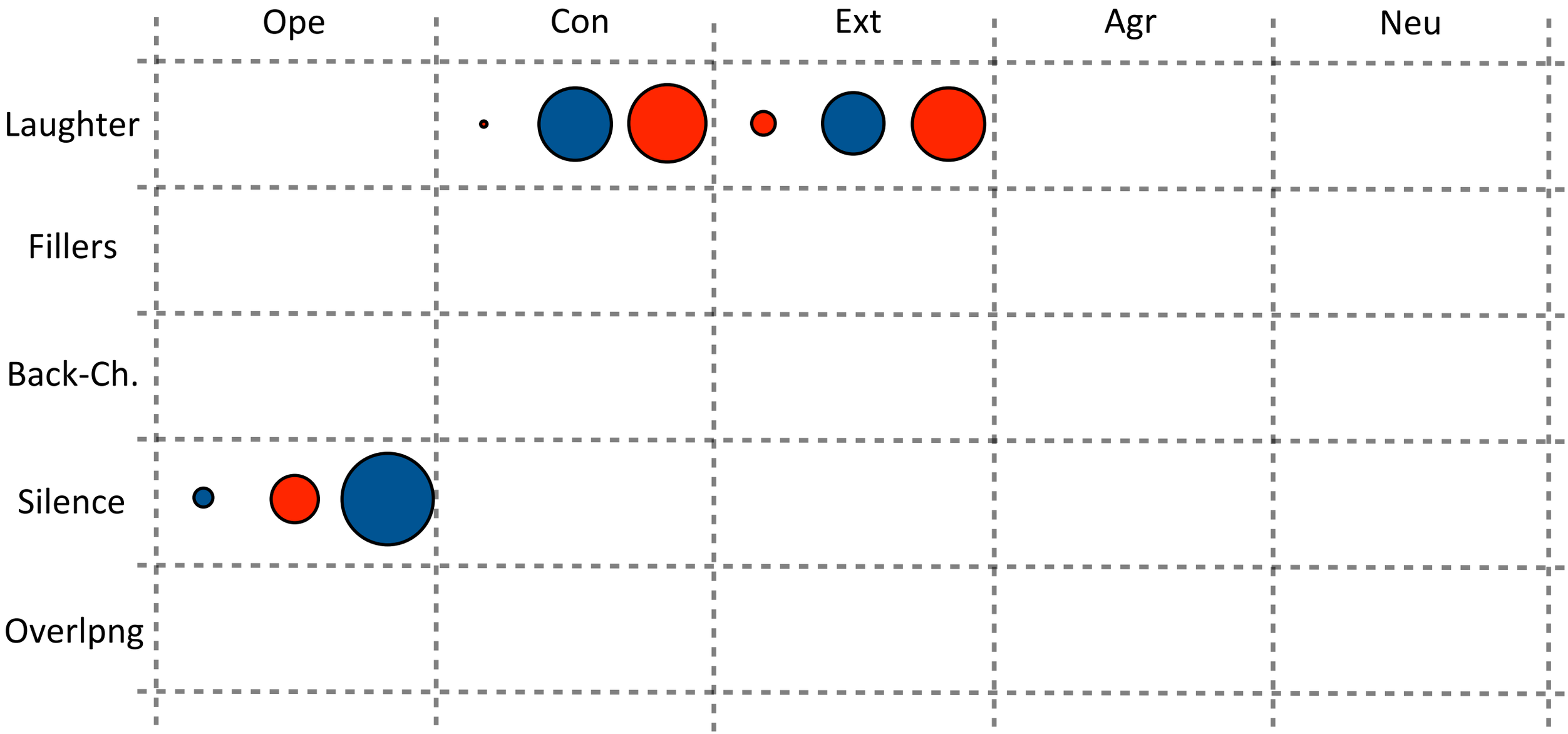
- Laughter, silence and overlapping significantly more frequent in "*social*";
- Back-channel significantly more frequent in "*task*".

Mode of Interaction Differences



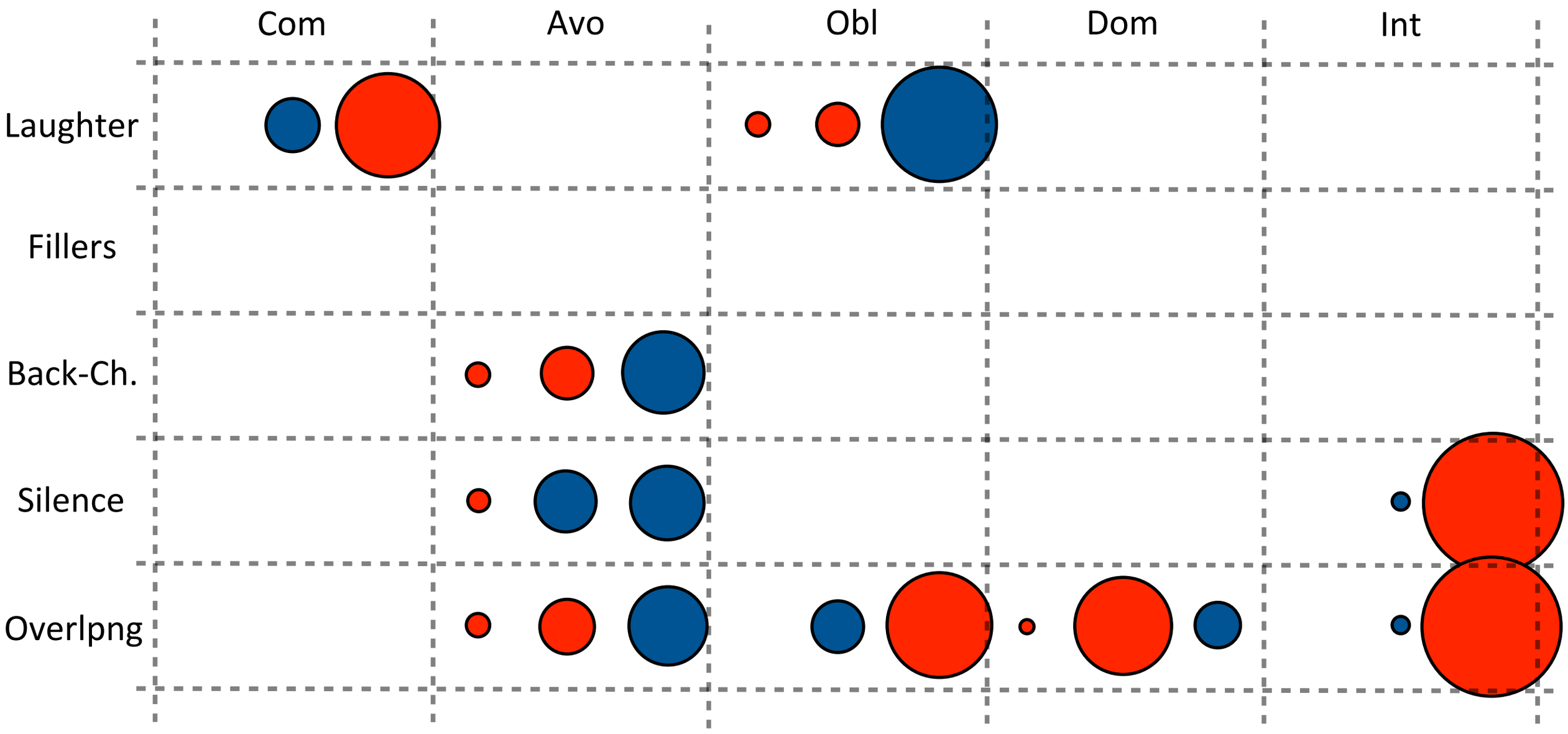
- Silence and overlapping significantly less frequent in "*disagreement*";
- Observations compatible with literature on cooperation.

Personality Differences



- Con. and Ext. laugh significantly less, while Ope. are significantly more silent;
- Overall, relevance of personality traits is low.

Conflict Handling Differences



- Overlapping interacts significantly with conflict handling style;
- Observations compatible with literature on conflict.

Outline

- The Rise of "*Socialism*" in Computing
- Social Signal Processing
- Observing Behaviour
- Conclusions

Conclusions

- Nonverbal behavior conveys information about social and affective phenomena
- Information corresponds to statistically significant deviations with respect to the expected frequency
- Statistically significant deviations can be detected to infer the phenomena they co-occur with