The cognitive science of interactive language

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Individuals vs. systems

- Vast majority of research into human cognition (and cognitive neuroscience) is concerned with the individual
- But a systems-level approach is very important and practically relevant
  - Human-human interaction
 - Human-computer interaction

Interactive language

- Natural language dialogue is fundamental to interaction
  - Involves linguistic but also non-linguistic aspects (gestures, pictures, etc.)
- Understanding dialogue involves
  - Cognitive neuroscience, psychology, linguistics
  - Computer scientists, electrical engineers, etc.

Views of interaction

- Traditional view
  - Interaction just "adds noise"
- Our view
  - Natural cognitive systems did not evolve in isolation
  - They evolved by developing mechanisms for interaction
- Challenge
  - To understand natural interactive mechanisms
  - Through behavioural and neuroscientific experimentation, modelling, etc.
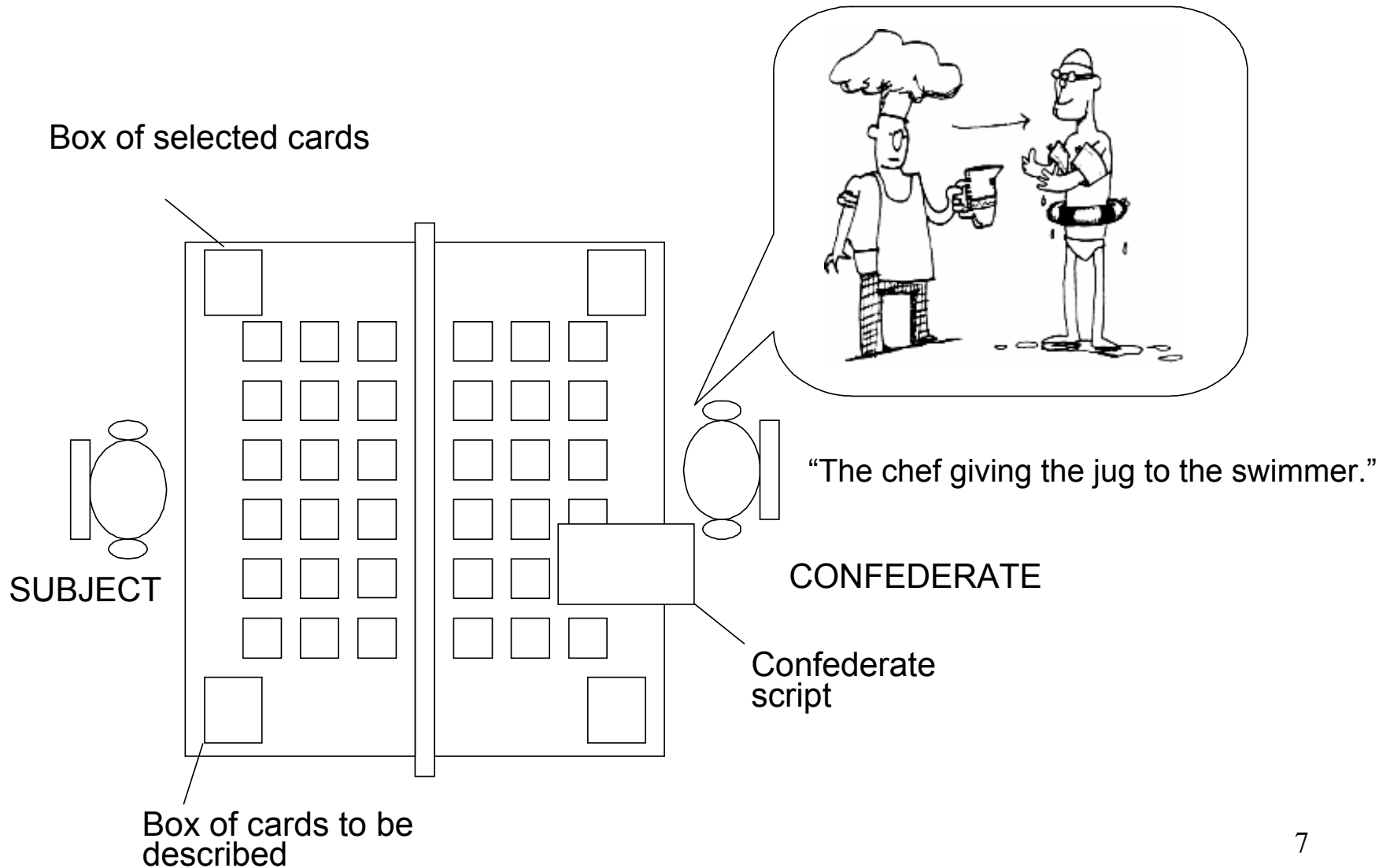
Information *alignment* rather than information *transfer*

Drawing by Stevenson; © 1976 The New Yorker Magazine, Inc.
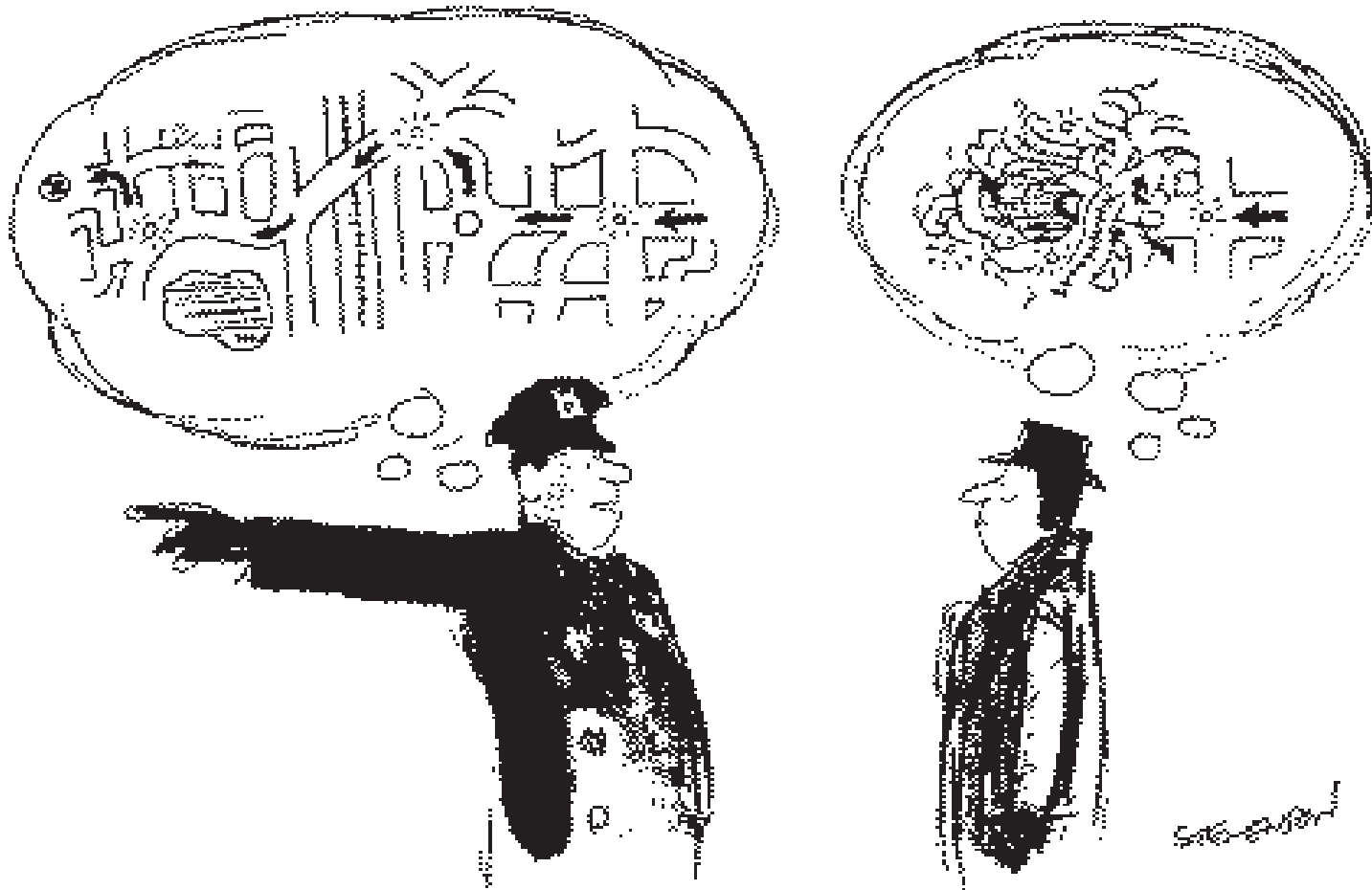
Alignment

- In successful conversations, interlocutors eventually share relevant knowledge
  - Their "mental models" converge
- Alignment may occur via extensive reasoning about each others' minds
  - working out what they know and what they don't
- Or it may occur via fairly automatic "priming" mechanisms
  - Interlocutors tend to repeat each others' word choices, grammatical choices, etc.

Studying interactive alignment

Box of selected cards

"The chef giving the jug to the swimmer."

SUBJECT

CONFEDERATE

Confederate script

Box of cards to be described

The study of dialogue

- Dialogue clearly more basic than monologue
- But current mechanistic accounts of language use are concerned with monologue
  - Comprehension and production of isolated words and sentences, reading texts …
- For example, EEG/fMRI studies of word recognition in isolation
  - Contrasts with a social cognitive neuroscience of language
- Generalizes far beyond language
  - e.g., interactive problem solving

Computational applications

- Importance of dialogue systems
  - Direction-giving systems, travel/entertainment booking systems
  - But hampered by non-interactive approaches to cognition
  - Such systems will benefit enormously from cognitive/neuroscientific approaches to language over the next 2 decades or so
  - Relevance of planning in sensory-motor domains
    - Integration of linguistic and non-linguistic planning
    - Relevance of animal as well as human work

Eye-tracking technology

- An example of a sophisticated methodology that can be employed during natural interaction

- Allows moment-by-moment investigation of the processes in interactive language use
  - Recent work investigates where people look while speaking and listening
  - But almost no work investigating dialogue
    - e.g., synchronization between interlocutors

Towards a research programme

- Controlled scientific investigation of natural interaction using hybrid methods
  - Analysing speech, eye movements
  - Integration of cognitive neuroscientific methods
  - Computational modelling
- Replace study of isolated utterances with a study of *situated* interaction, drawing upon the multimodal context
  - Facial and manual gestures
  - Physical surroundings

Research questions & approaches

- Dialogue and alignment of attention
  - Dialogue-based 'visual world paradigm' experiments
- Computational modeling of the alignment process
- Defining the dialogue-monologue continuum
- Role of feedback, reciprocity, social factors in interactive alignment
  - e.g., investigate effects of group size on discussions using sophisticated multi-speaker monitoring equipment