



Intentionality in Speech

Implications for Computational Models

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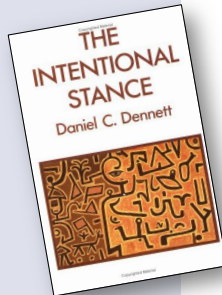
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Teleological Behaviour



Dennett, D. (1989).
The Intentional
Stance. MIT Press.

- The behaviour of (*intelligent*) living systems is **intentional!**
- This doesn't mean that an organism 'knows' what it is doing!
- It simply means that an organism has **preferred states**, and that actions are selected in order to achieve those states
- This places a focus, not on actions, but on the **consequences** of actions
- This, in turn, leads to very interesting forms of **coupling** between ...
 - an agent and its environment
 - an agent and another agent



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Communicating Intentions

"I ... do ... not ... know"
"I do not know"
"I don't know"
"I dunno"
"dunno"
[ə̃ə̃ə̃]

Hawkins, S. (2003). Roles and representations of systematic fine phonetic detail in speech understanding. *Journal of Phonetics*, 31, 373-405.

- Signalling involves physical/mental effort
- Large effort creates clear signals but uses more energy (*and vice versa*)
- The 'target' is a perception not a signal
- So optimisation is over competing perceptions not competing signals
- The intention is sufficient **contrast** at the pragmatic level (*leading to suitable compensations at the semantic, syntactic, lexical, phonemic, phonetic and acoustic levels*)
- The **obstacles** are ...
 - alternative interpretations (*internal*)
 - competing signals (*external*)



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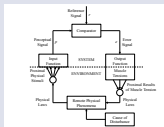
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Feedback



Perceptual Control Theory



- The structural coupling of an agent with its environment (*including other agents*) implies **feedback**
- Feedback is a **regulatory** process
- Feedback facilitates ...
 - the management of energy and entropy
 - the maintenance of stability
 - the comparison of achievements against intentions

“feedback ... is the central and determining factor in all observed behavior”

W. T. Powers (1973). *Behaviour: The Control of Perception*, Aldine, Chicago.



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Evidence for Such Behaviour



- People naturally tend to speak louder/differently in noise (*Lombard, 1911*)
- Caregivers talk differently to children (*Fernald, 1985*)
- Speakers actively control articulatory effort (*Lindblom, 1990*)
- Users talk differently to machines (*Moore & Morris, 1992*)
- Being able to hear your own voice has a profound effect on speaking (*as evidenced by the need for sidetone on a telephone*)
- Hearing-impaired individuals can have great difficulty maintaining clear pronunciations (*or level control*)
- Delayed auditory feedback causes stuttering-like behaviour
- People with speaking difficulties (*e.g. caused by cerebral palsy*) report that it takes immense effort to produce even the simplest utterance
- Altered auditory feedback evokes compensations (*Munhall et al, 2009; MacDonald et al, 2011*)



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Consequences for SLP



- Need computational paradigms that are able to accommodate such dependencies
- Communicative **obstacles** are overcome using ...
 - sufficient effort
 - feedback
- Communicative **effort** is related to ...
 - the fidelity of the representations
 - the depth of the searches



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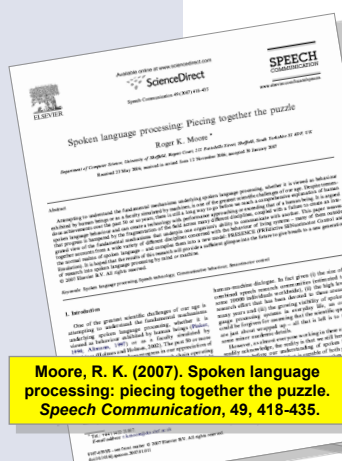
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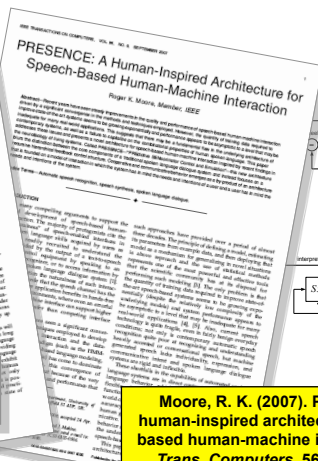


PreSenCE

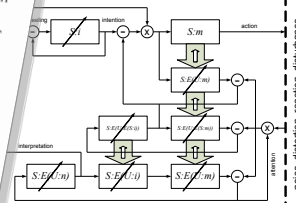
Predictive Sensorimotor Control and Emulation



Moore, R. K. (2007). Spoken language processing: piecing together the puzzle. *Speech Communication*, 49, 418-435.



Moore, R. K. (2007). PRESENCE: A human-inspired architecture for speech-based human-machine interaction. *IEEE Trans. Computers*, 56(9), 1176-1188.



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Reactive Speech Synthesis



Reactive Speech Synthesis



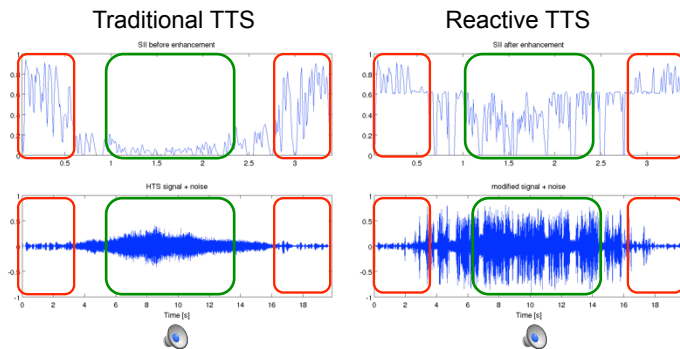
Mauro Nicolao



SCALE



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Automatic compensation for disturbance

Moore, R. K., & Nicolao, M. (2011). Reactive speech synthesis: actively managing phonetic contrast along an H&H continuum, 17th International Congress of Phonetics Sciences (ICPhS), Hong Kong.

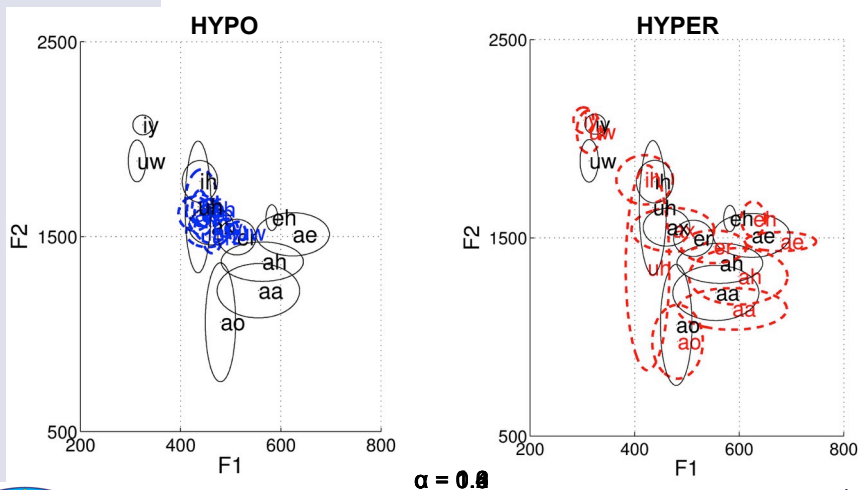


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Effect on Vowel Space



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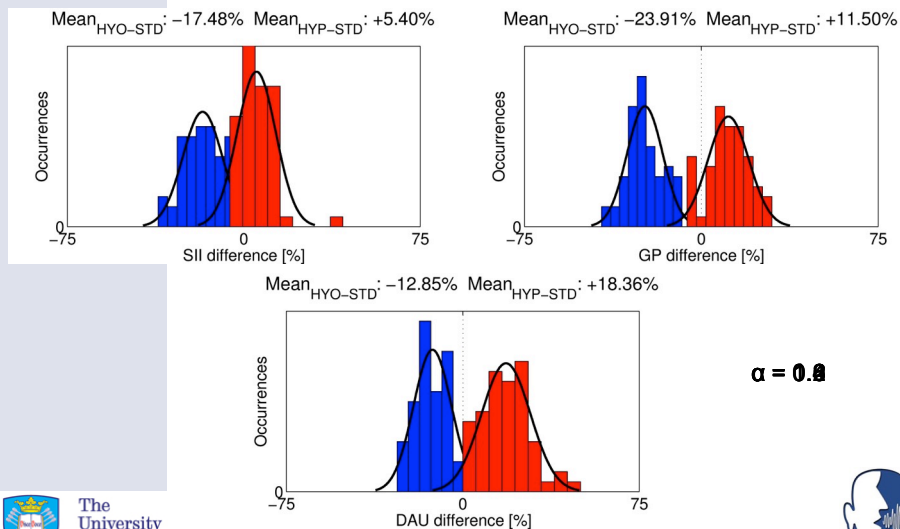
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Effect on Intelligibility



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Reactive Speech Synthesis

Type of noise	HYPO	NORM	HYPER
Speech Shaped Noise (SNR = 1 dB)			
Competing Talker (SNR = -7 dB)			
Clean			

*"The box was thrown beside
the parked truck"*



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Reactive Speech Synthesis

Type of noise	HYPO	NORM	HYPER
Car Noise (SNR = -4 dB)			
Babble Noise (SNR = -4 dB)			
Competing Talkers (SNR = -4 dB)			
Clean			

Nicolao, M., Tesser, F., & Moore, R. K. (2013). A phonetic-contrast motivated adaptation to control the degree-of-articulation on Italian HMM-based synthetic voices. In *8th ISCA Speech Synthesis Workshop (SSW8)*. Barcelona, Spain.



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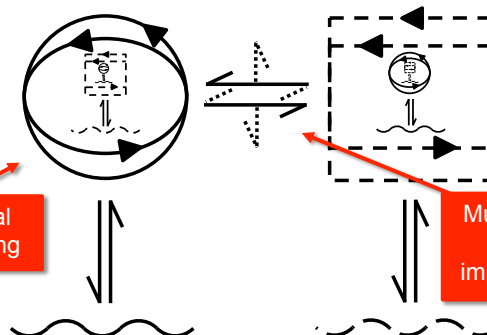
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Concluding Remarks



Ostensive inferential
recursive mindreading



Mutual declarative,
interrogative,
imperative coupling

Moore, R. K. (2016). Introducing a pictographic language for envisioning a rich variety of enactive systems with different degrees of complexity. *Int. J. Advanced Robotic Systems*, 13(74).



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