

Language processing in schizophrenia: Top-down & bottom-up effects.

Introduction A robust body of work now suggests that sentence comprehension is driven by the immediate parallel integration of both 'bottom-up' sensory/lexical information and 'top-down' discourse/pragmatic cues [Altmann, 1999]. One possibility, then, is that very similar mechanisms are used to integrate both high-level and low-level information sources. Neuropsychiatric populations may provide a reason to question this conclusion. For instance, in schizophrenia, it has been argued that a selective deficit of *top-down* integration may explain many of the associated cognitive impairments, including impairments to language comprehension [Cohen & Servain-Schreiber, 1992]. If so, top-down and bottom-up effects on sentence processing may dissociate in schizophrenia.

Methods: Using a fully within-subjects battery of four visual-world experiments, we compared top-down and bottom-up processing in 19 healthy controls and 19 patients with schizophrenia, matched on age, SES and pre-morbid verbal IQ. We examined how bottom-up information and top-down information are used to resolve prepositional phrase attachment ambiguities (*tickle the frog with the feather*, heard in front of a Target animal [frog with feather], Target instrument [feather], Distracter animal, and Distracter instrument. Each cue was manipulated to push the PP to either to serve as an **Instrument (Ins)** phrase [tickle [the frog] with the feather] or to **Modify (Mod)** the NP [tickle [the frog with the feather]].

Bottom-up cues. Expt1: Prosodic Contour: **Ins:** *tickle the frog...with the feather*; **Mod:** *tickle...the frog with the feather*; 4 trials/condition. **Expt2: Structural Bias of the Verb:** **Ins:** *tickle the frog with the feather*; **Mod:** *find the panda with the stick*; 8 trials/condition.

Top-down cues. Expt3: Prior Discourse. A 2nd speaker asked either **Ins:** *What should we do to a frog? or Mod:* *Which frog should we use now?*, followed by the 1st speaker giving the target instruction, *tickle the frog with the feather*, 4 trials/condition. **Expt4: Referential Context** **Ins:** 1 or **Mod:** 2 potential frog referents, 8 trials/condition.

In each experiment, we crossed Bias (**Ins/Mod**) with Group (patient/control). We examined (a) participants' offline cue integration through the actions they ultimately performed; and (b) their ability to integrate these cues during online comprehension, as indexed by how Bias affected gaze to the Target instrument over 1500ms after the PP noun's onset, with statistically reliable time-windows extracted using resampling [Maris & Oostenveld, 2007].

Results: (a) Actions Patients and controls showed similarly successful offline integration of both bottom-up and top-down cues. In all experiments, both groups used the Target instrument more often in **Ins** trials (all effects of Bias, $p < .05$; no Group*Bias interactions, all $p > .25$).

(b) Online processing. *In the bottom-up experiments*, the groups showed similar gaze patterns. Overall, **Ins**-biased **Prosodic** cues resulted in more looks to the Target instrument than **Mod**-biased cues, although the effect was delayed in patients (Bias*Group interaction 500-900ms, follow-ups: effect of Bias in Controls 500-1500ms, and in Patients 700-1500ms, all $p < .01$). Similarly, hearing **Ins**-biased **Verbs** led both groups to look more at the Target instrument than **Mod**-biased verbs, with similar time courses (effect of Bias 100-1500ms, $p < .01$, interaction ns.).

In the top-down experiments, however, qualitative differences emerged between the groups. We found a Bias*Group interaction (600-1000ms, $p < .01$) that arose because **Discourse** affected whether controls looked at the instrument (400-1100ms, $p < .01$), but did not reliably affect patients' fixation patterns at any individual time-point). **Referential Context** showed a marginal Bias*Group interaction ($p \sim .1$), due to marginal reversed effects in each Group.

Conclusions Patients with schizophrenia use both top-down and bottom-up information in *offline* actions, but show specifically impaired *online* integration of top-down discourse cues, despite comparatively spared bottom-up prosodic and lexical integration. Beyond informing our understanding of language in schizophrenia, this dissociation suggests an important distinction in the mechanisms by which top-down and bottom-up information are integrated online.