

**Predicting the future in rhythm and language:
the relationship between anticipation abilities in Italian-speaking preschoolers**

Humans are constantly engaged in predicting the future. For instance, while executing a simple rhythmic motor task requiring to synchronize movements to a periodic rhythmic sound (e.g. in a tapping task), we anticipate features of the incoming input in order to be in time with the rhythm; crucially, predictions about the new input are cued by the features of the already parsed rhythmic structure (Miyake, Onishi, & Pöppel, 2004; Fraisse & Repp, 2012). Linguistically, while processing a sentence, listeners incrementally integrate linguistic input into the already parsed sentence fragment and use its features to anticipate what the next input will be. Psycholinguistic research has shown that listeners make use of different pieces of grammatical information at different stages of the parsing process and has described how grammatical information cues anticipation phenomena (Kamide, 2008). In addition to syntactic and semantic information, rhythmic features of the sound structure of language have been shown to cue disambiguation and anticipation processes in sentence comprehension, as well as acquisition processes (Bion, Benavides-Varela, & Nespors, 2011; Jusczyk, Hohne, & Mandel, 1995; Roncaglia-Denissen, Schmidt-Kassow, & Kotz, 2013). Although rhythmic features of speech are relevant for language processing and its acquisition, only a few studies have directly investigated the relationship between rhythmic and linguistic abilities. Some recent research has reported rhythm difficulties in both speech and music in children with Specific Language Impairment and children with Developmental Dyslexia (Cumming, 2015; Goswami, 2011; Goswami & Leong, 2013; Pagliarini, 2016; Thomson et al., 2006; Thomson & Goswami, 2008; Gordon, Jacobs, Schuele, & McAuley, 2015). These studies have mainly focused on the relationship between non-linguistic rhythmic abilities and phonological-prosodic abilities and have argued that children who have worse musical rhythmic abilities are less efficient at processing and representing changes in the speech prosody marking syntactic elements, and, thus, that they have a language acquisition disadvantage. However, in order to further investigate the relation between rhythm and language, one important issue concerns the relationship between rhythmic anticipation and the linguistic anticipation that is not directly triggered by prosodic cues. The anticipation triggered by morphosyntactic information, as in the case of functional words predicting future occurrences of content words, is an example. In order to address this issue, we investigated the relation between rhythmic and linguistic anticipation in 48 Italian-speaking preschoolers (4-6 yrs). Children were administered a rhythmic task (the *warning-imperative task -WIT-*) and two linguistic tasks (the *determiner processing task -DPT-* and the *clitic processing task -CPT-*). In the **WIT**, children familiarized with sequences of sounds in which a warning sound provided information on the occurrence of a future imperative stimulus triggering a motor response. Sound sequences occurred in a *spondee* condition with 0.15s long sounds played at a frequency of 0.75Hz and in a *trochee* condition with sequences of two sounds with 0.15s and 0.10s duration played at a frequency of 0.75Hz. Warning sounds (WSs) were created by adding a harmonic to the basic sounds (pure 440Hz) and were randomly distributed throughout the rhythmic sequence. WSs alerted the participant to tap in synchrony with the following beat, called the imperative (IS). In the **DPT** children were asked to identify the referent of singular masculine and singular feminine nouns introduced by a definite determiner. Determiner and noun were separated by the prenominal unmarked adjective *grande* (*big*). The referent and a competitor of different gender were presented in a picture selection paradigm measuring response accuracy and reaction times. In the **CPT** children were asked to identify the referent of third singular masculine and third singular feminine clitics occurring in a sentence with a postverbal agreeing DP; sentences for the CPT were created following Léger et al. (2012). In the DPT and CPT nouns were presented in

three conditions in which we manipulated the gender information associated with the noun (grammatical, phonological and semantic). **Results.** We divided the participants into two age groups: one with children younger than 5;6, the other with children older than 5;6. Preliminary analyses of the data show that: (1) older children perform better than younger ones in both rhythmic and linguistic tasks; (ii) the use of gender morphology is faster in the GPS and GP conditions than in G, suggesting that children follow a procedural agreement strategy when anticipating the noun referent; (iii) RTs in the determiner processing task correlate with rhythmic off-beat proportions (RT < -100ms or RT > +100) (OBP) in the younger group. These preliminary data suggest that the maturation of principles of rhythmic organization impacts on the acquisition of language abilities.

DPT

CPT

GRAMMATICAL, PHONOLOGICAL & SEMANTIC (GPS)

(1) *Pinky tocca la grande fatina*
Pinky touches **the^f** big **fairy^f**



(3) *Pinky la tocca velocemente la fatina*
Pinky **CL^f** touches quickly **the^f** fairy^f

(2) *Pinky tocca il grande marinaio*
Pinky touches **the^m** big **sailor^m**

(4) *Pinky lo tocca velocemente il marinaio*
Pinky **CL^m** touches quickly **the^m** sailor^m

GRAMMATICAL & PHONOLOGICAL (GP)

(5) *Pinky tocca la grande foglia*
Pinky touches **the^f** big **leaf^f**



(7) *Pinky la tocca velocemente la foglia*
Pinky **CL^f** touches quickly **the^f** leaf^f

(6) *Pinky tocca il grande fungo*
Pinky touches **the^m** big **mushroom^m**

(8) *Pinky lo tocca velocemente il fungo*
Pinky **CL^m** touches quickly **the^m** m.^m

GRAMMATICAL (G)

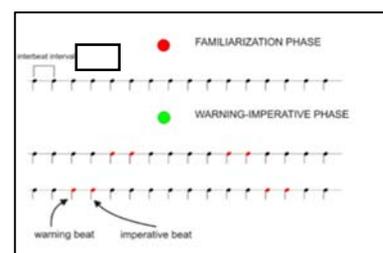
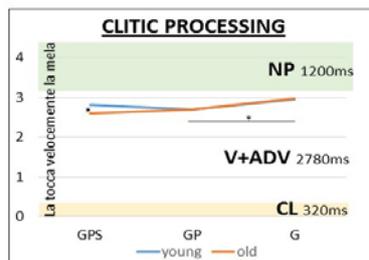
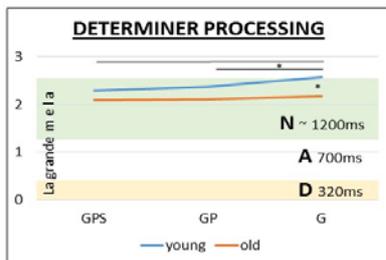
(9) *Pinky tocca la grande chiave*
Pinky touches **the^f** big **key^(f)**



(11) *Pinky tocca la velocemente la chiave*
Pinky **CL^f** touches quickly **the^f** key^(f)

(10) *Pinky tocca il grande fiore*
Pinky touches **the^m** big **flower^(f)**

(12) *Pinky tocca lo velocemente il fiore*
Pinky **CL^m** touches quickly **the^m** flower^(m)



Rhythm anticipation results

