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Abstract We construct a mapping from complex recursive linguistic data structures to spherical wave functions using

Smolensky's filler/role bindings and tensor product representations. Syntactic language processing is then described by the transient evolution of these spherical patterns whose amplitudes are governed by nonlinear order parameter equations. Implications of the model in terms of brain wave dynamics are indicated.

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1 Introduction

n n ρr $n \rightarrow \rho$ $n \rightarrow 1$ γ $l \rightarrow n$ n n $r \rho \gamma \rightarrow r$ n $r \rightarrow n$ r l n $r \rightarrow l$ nn r $n r \rightarrow n$ r nl nl n $r \rightarrow \rho$ -1 γ $n \rho$ n r $l r n \rho n \rightarrow r$ γn r n l $2, r \rightarrow l r \rightarrow \rho$ $n \rightarrow n - r$ $\gamma r l$ n l ρr -1 N n - 1 1 - 2 r n $2, \rho r$ $n \rho r$ -1 N n - 1 1 - 2 r n $2, \rho r$ $n \rho r$

2 2 2 2 2

2 Grammars

Cn-kr nn

Example 1 n e

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pr 1-	r pr	≬ e		r na rn	n	٢	22

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Artniy,	С	Λ 11:	ry r	n n	- r	\in	/	n y

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r - ipnin - n

 $\mathbf{P}_{\mathbf{n}_{i}} \quad \mathbf{n}_{i} \quad \mathbf{$

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$$-\frac{1}{2}$$
 OP - 22

$$\mathbf{N}_{OP-1}$$

$$\mathbf{I} \in \mathbb{R}$$

$$22$$

r , pp r -n 1 $-\frac{1}{2}$

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 $r \geq$

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r, -, -, logistic function -, n n n l pr 2221 222

i 1 1 **i** '

8 Simulations

- **p** nry rpr nn r rpr p₀ 1 nl₂ Un **2** r nn - , rp - y¹
 - h^{\prime} $n \rightarrow n y$ $n n z \rightarrow$

- - ·

- n $r \rho r n n_1$ $\rho r \rho n_1$ $n n n n_1$ $r \rho - n_1$ $n - n_1$ $r \rho - n_2$ n_1 3 n_1 $r \rho - n_1$ 3 n_1 2 $r \rho - y$ n_1 n_1
 - $\frac{1}{2} \frac{1}{2} \frac{1}$
- All---n y, pr n $n \rightarrow lyn \rightarrow lyn \rightarrow lyn$
- -ir l-py pr -in r r l r pr r 1 , ln m p-i r pn l pr 1 , r l m r l r pr r -in 2 -i pm n -in a

References

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	r r r	n n	n e	2
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	Crnne ^e n p 2 r n e	n 0,	ny 1, 2	۱ ب
	Crnne "np prr-n	n	1	2
	yn - c l l l l , n l 2	rlrpr P ^{ll}	$n = \frac{1}{2}$	$\frac{1}{2}$
	- pr r	-	nlly	2
	Crnne ^{ee} np nne rn-n	n -n	lyn	l r pr p 2



Fig. 2 Left-derivation (3) of the sentence $\mbox{Susan ate grass}$ according to grammar (1).

FIGURES

 $\overbrace{r_2 \quad r_3}^{r_1}$

Fig. 3



Fig. 4 Tree roles in a spin-one term schema.



Fig. 6 (Color online) Snapshot sequence of the state s_1 with higher temporal resolution.



Fig. 8