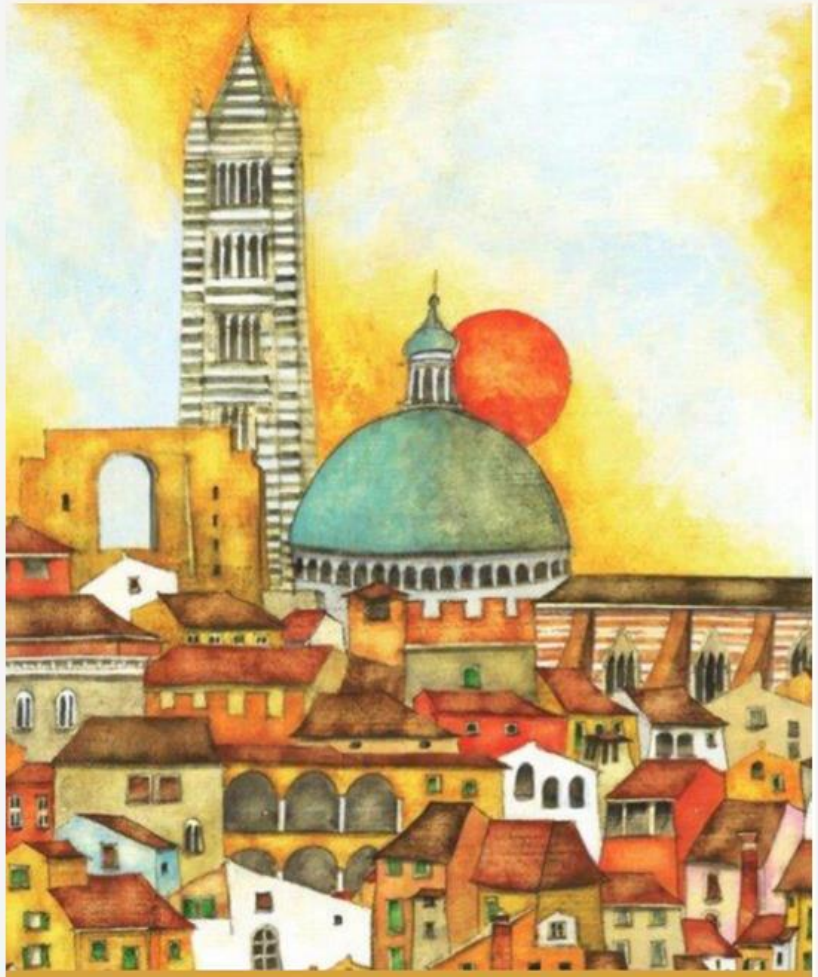
SIPF

Società Italiana di Psicofisiologia e Neuroscienze Cognitive



Human Robot Interaction: the influence of putative pheromones, gender voice and proxemic space variations on behavioral and electrophysiological responses

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DIPARTIMENTO DI SCIENZE E TECNOLOGIE BIOLOGICHE ED AMBIENTALI

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Background

Human putative pheromones

Olfactory vs vomeronasal epithelium (*Monti-Bloch et al., 1994)*

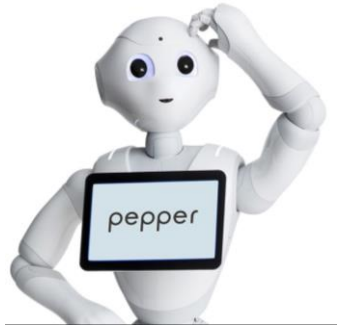
Independent from the olfactory pathway (*Savic and Lindström, 2008; Mazzatenta et al., 2013)*

Social chemosignals acting below the consciousness threshold *(Pause, 2012)*

Odorant information small enough to prevent top-down brain regulations could influence humans' autonomous responses and social sympathy judgments *(Li et al., 2007)*

The use of putative pheromones fosters a number of behavioral and psychophysiological responses

Johansson and Jones, 2007; Secundo et al., 2014



Human-robot interaction (HRI)

It is a continuously developing area

Humanoid robots lack pheromones and sexual gender

They can be interfaced with neural recording systems

frontiers in Systems Neuroscience

ORIGINAL RESEARCH
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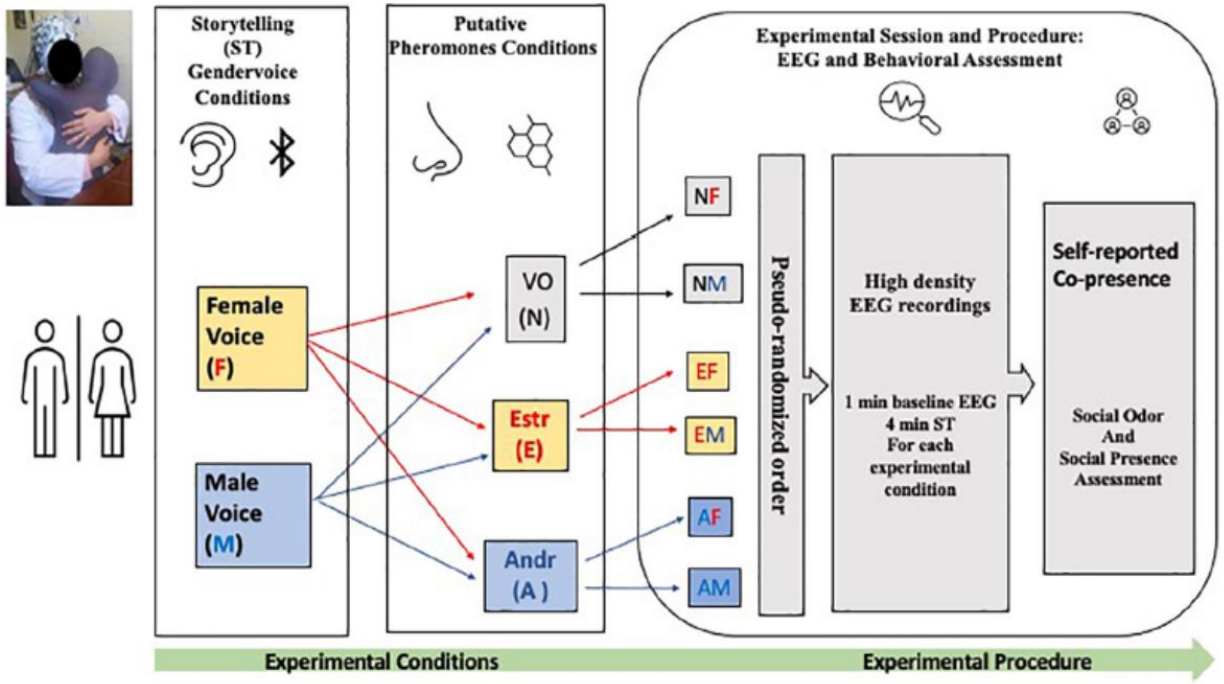
Perception of Social Odor and Gender-Related Differences Investigated Through the Use of Transfer Entropy and Embodied Medium

Sara Invitto[1], Soheil Keshmiri[2]*, Andrea Mazzatenta[3], Alberto Grasso[1], Daniele Romano[4,5], Fabio Bona[1], Masahiro Shiomi[6], Hidenobu Sumioka[7] and Hiroshi Ishiguro[7,8]*



- **Task:** story listening of the italian version of «Freddie the leaf» by Leo F. Buscaglia with female (F) or male (M) voice.
- **Olfactory stimuli:**
  - Estratetraen-3-ol-17-one (Estr, E)
  - 5α-Androst-16-en-3α-ol (Andr, A)
  - Vaseline oil (VO, N)
- **EEG recording**
- **Questionnaires** Sense of co-presence and social presence *(Nowak & Biocca, 2003)*.

Results

- Andr induced more co-presence than Estr and VO
- Greater co-presence desire in women
- EEG signal was more sensitive to the mismatch between Estr and the male voice condition

Experimental procedure

- **NAO robot** (Aldebaran): interfaced with 64 channels EEG system, pseudorandomly select one out of four movements to be performed every 10 s.
- **Olfactory stimuli:**
  - Estratetraen-3-ol-17-one (Estr, E)
  - 5α-Androst-16-en-3α-ol (Andr, A)
  - Vaseline oil (VO, N)
- **EEG recording**
- **Questionnaires:** sense of co-presence and social presence *(Nowak & Biocca, 2003)*.

Statistical analysis – Behavioral results

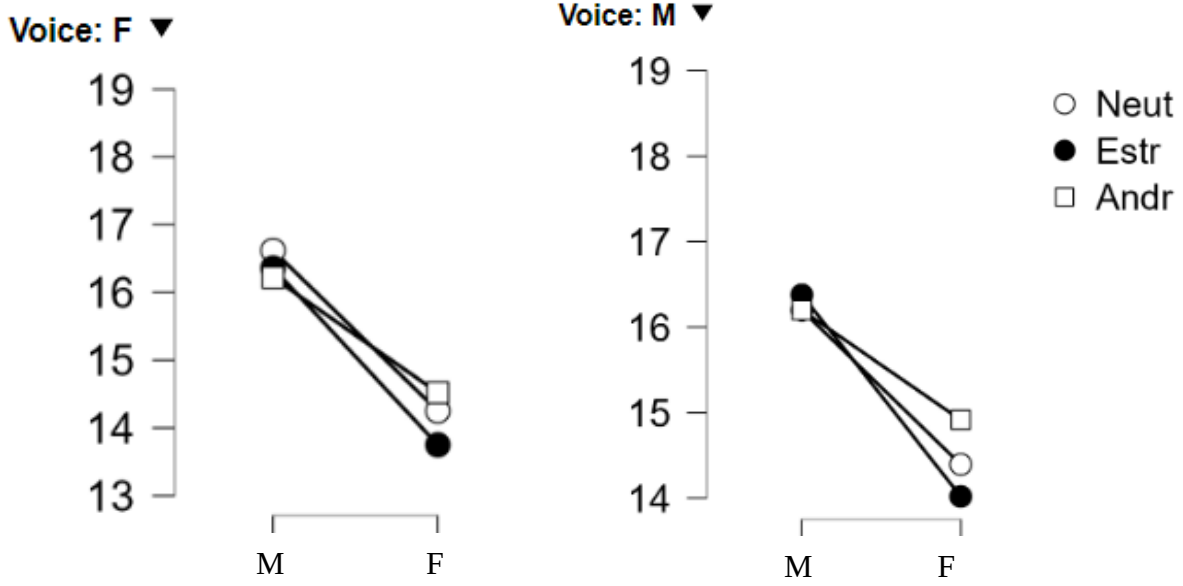
Repeated measures ANOVA

- Pheromones (N, E, A)
- Voice gender (F, M)
- Presence (CoPres, SocPres)

Within factors

- Sex (M, F)

Between factor



Between Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
Sesso	600.146	1	600.146	6.240	0.016	0.079
Residuals	4520.327	47	96.177			

Regardless of the pheromones and voice gender conditions, female subjects show greater copresence, as also found in *Invitto et al., 2021*

Statistical analysis – Electrophysiological results

Repeated measures ANOVA

- Pheromones (N, E, A)
- Voice gender (F, M)
- Proxemic space (Forward, Backward)
- Body (Arms, Legs)

} Within factors

- Sex (M, W)

} Between factor

ERP Amplitude – N200

Fz

Within Subjects Effects

Cases	Sum of squares	Df	Mean square	F	*p*	η^2
Pheromone	2.491	2	1.245	25.333	< .001***	0.041
Voice	7.598	1	7.598	16.173	< .001***	0.012
Prox space	2.523	1	2.523	7.933	0.007**	0.004
Prox space ✻ sex	1.900	1	1.900	5.973	0.018*	0.003
Pheromone ✻ voice	1.679	2	8.397	9.945	< .001***	0.027

Between Subjects Effects

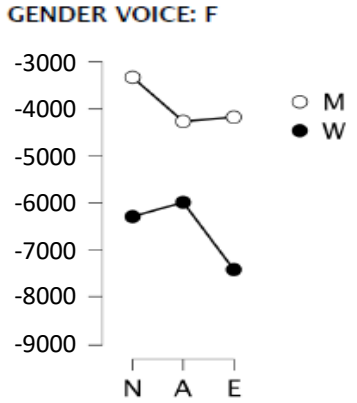
Cases	Sum of squares	Df	Mean square	F	*p*	η^2
Sex	1.639	1	1.639	5.989	0.018*	0.027
Residuals	1.314	48	2.737			

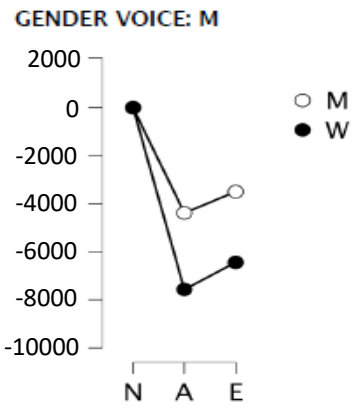
Post Hoc Comparisons – PHEROMONE

		Mean Difference	SE	t	p_{holm}
N	A	3.147	4.974	6.326	< .001***
	E	2.979	4.974	5.988	< .001***

Post Hoc Comparisons – PHEROMONE* VOICE

		Mean Difference	SE	t	p_{holm}
N, F	N, M	-4.810	8.509	-5.653	< .001***
A, F	N, M	-5.127	7.393	-6.934	< .001***
E, F	N, M	-5.798	7.393	7.842	< .001***
N, M	A, M	5.977	8.199	7.289	< .001***
N, M	E, M	4.969	8.199	6.060	< .001***





Statistical analysis – Electrophysiological results

ERP Amplitude – N330

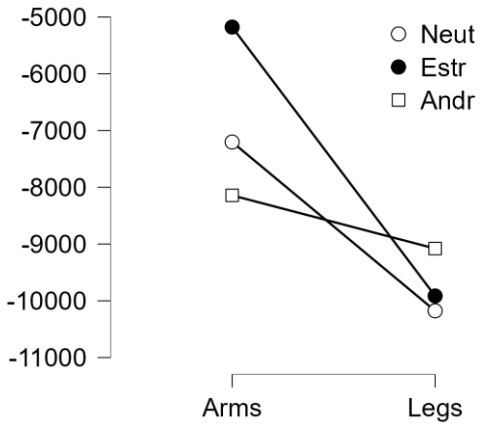
AFz

Within subjects effects

Cases	Sum of squares	Df	Mean square	F	*p*	η^2
Pheromone * Body	6.987	2	4.753	4.852	0.019	0.005

Post Hoc Comparisons - Pheromone ✻ Body

		Mean Difference	SE	t	Cohen's d	p_{holm}
N, Arms	N, Legs	3.000	9.425	3.183	0.270	0.022*
E, Arms	A, Arms	2.944	1.006	2.926	0.265	0.043*
	N, Legs	5.028	1.080	4.656	0.452	< .001***
	E, Legs	4.753	9.425	5.043	0.427	< .001***
	A, Legs	3.924	1.080	3.634	0.353	0.005**



Fz

Within subjects effects

Cases	Sum of squares	Df	Mean square	F	*p*	η^2
Pheromone * Voice	3.503	2	1.774	3.384	0.039	0.005

Post-hoc comparisons were not significant

Between Subjects Effects

Cases	Sum of squares	Df	Mean square	F	*p*	η^2
Sex	2.948	1	4.753	5.411	0.024	0.038
Residuals	2.561	47	5.449			

Statistical analysis – Electrophysiological results

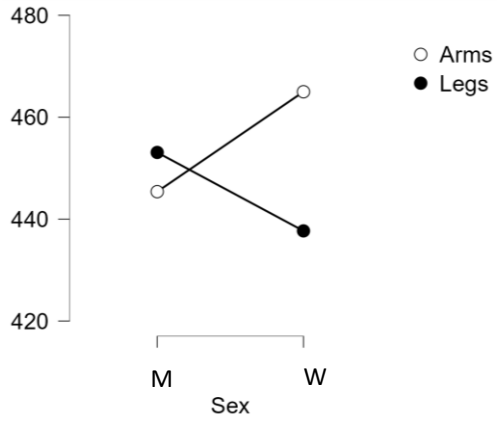
ERP Latency – N330

Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	*p*	η^2
Body	2824	1	2824	4.188	0.046*	0.003
Body ✻ Sex	9001	1	9001	13.344	< .001***	0.010
Prox Space ✻ Body	4042	1	4042	5.854	0.019*	0.004

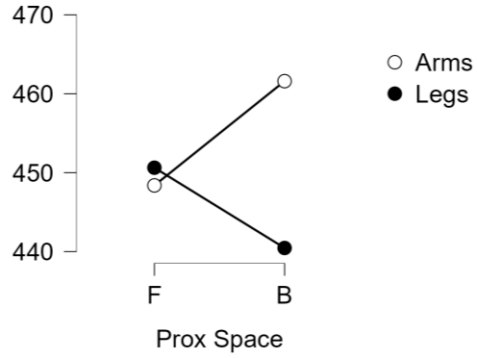
Post Hoc Comparisons - Sex ✻ Body

		Mean Difference	SE	t	p_{holm}
M, Arms	W, Arms	-19.606	7.425	-2.641	0.049*
W, Arms	W, Legs	27.306	6.844	3.990	0.001*

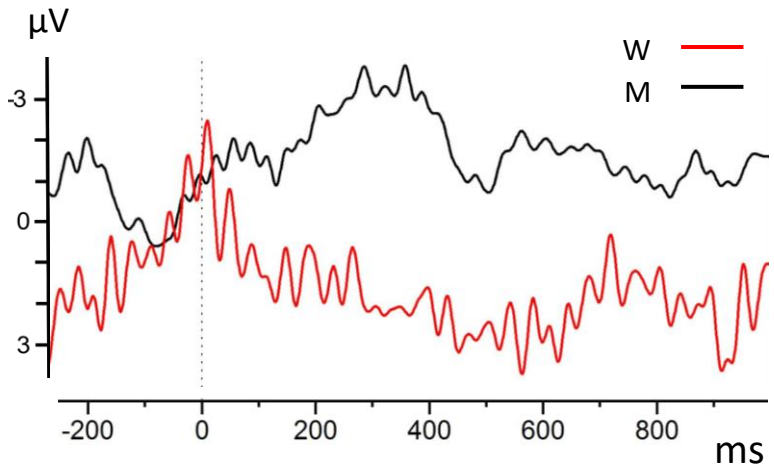


Post Hoc Comparisons - Prox Space ✻ Body

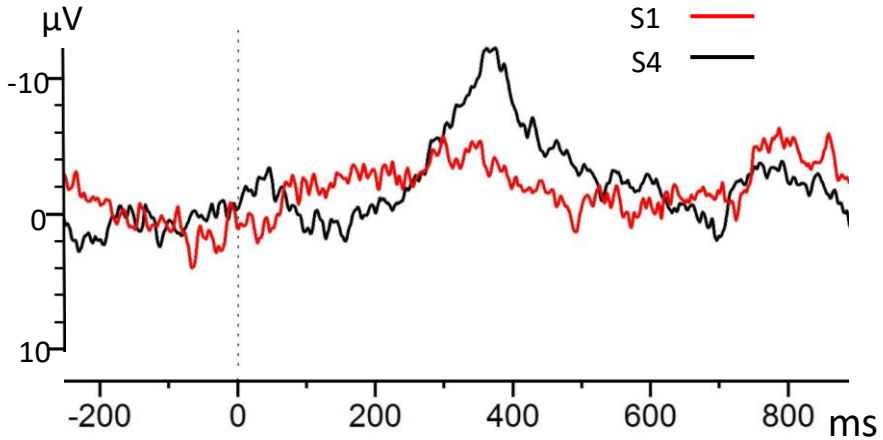
		Mean Difference	SE	t	p_{holm}
B, Arms	B, Legs	21.533	6.815	3.159	0.013*

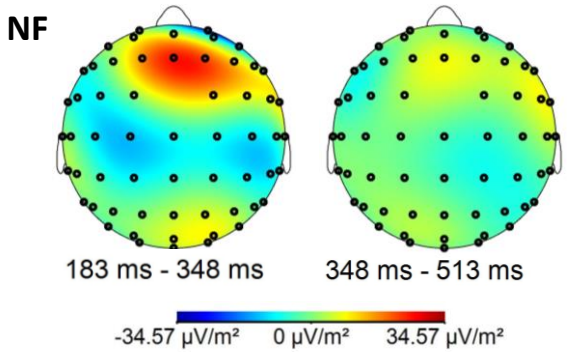


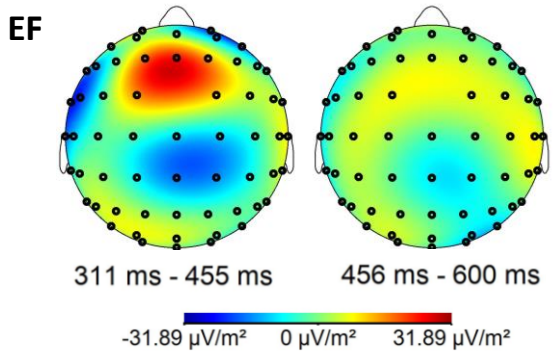
Fz AF – Walk forward

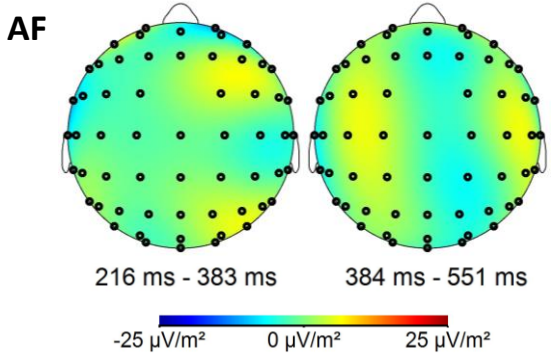


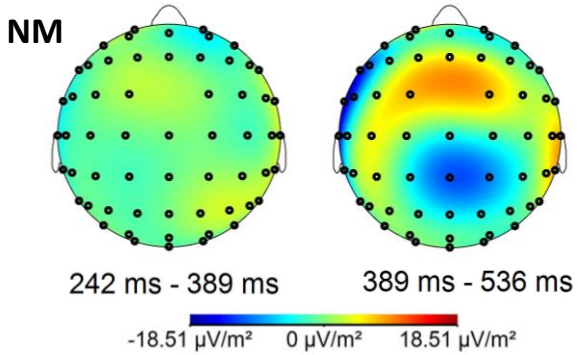
Cz EF – Walk forward (S1) vs walk backward (S4)

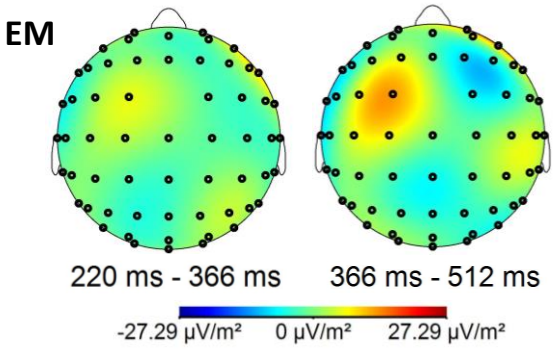


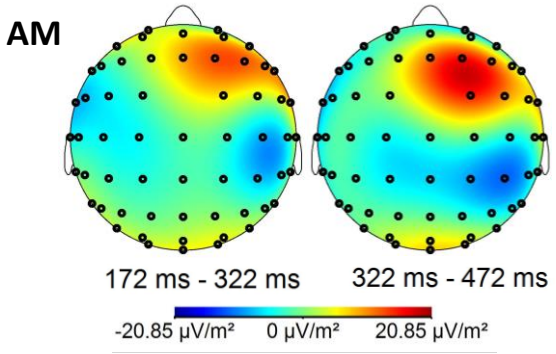












THANK YOU
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