R&I

IN3
Internet
Interdisciplinary
Institute

Sensor-based proximity metrics for team research. A benchmarking and validation study across three organizational contexts.

GenTIC
Researching Gender
in the Network Society

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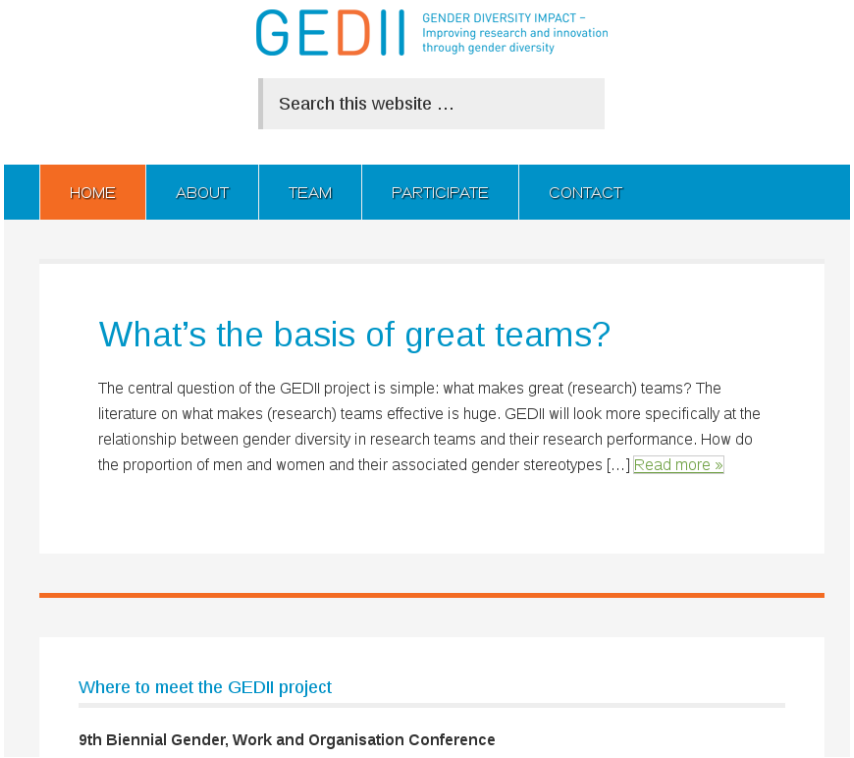
Julio Meneses (UOC)
Anne Laure Humbert (Oxford Brookes)
Elisabeth Anna Guenther (WU Wien)

14th ESA Conference, // 20-23 August 2019
Manchester, UK

GEDII Project
Gender Diversity in R&D Teams



H2020 Science with and for Society

Duration
Oct 2015 – Sep 2018

http://www.gedii.eu

Horizon 2020
European Union Funding for Research & Innovation

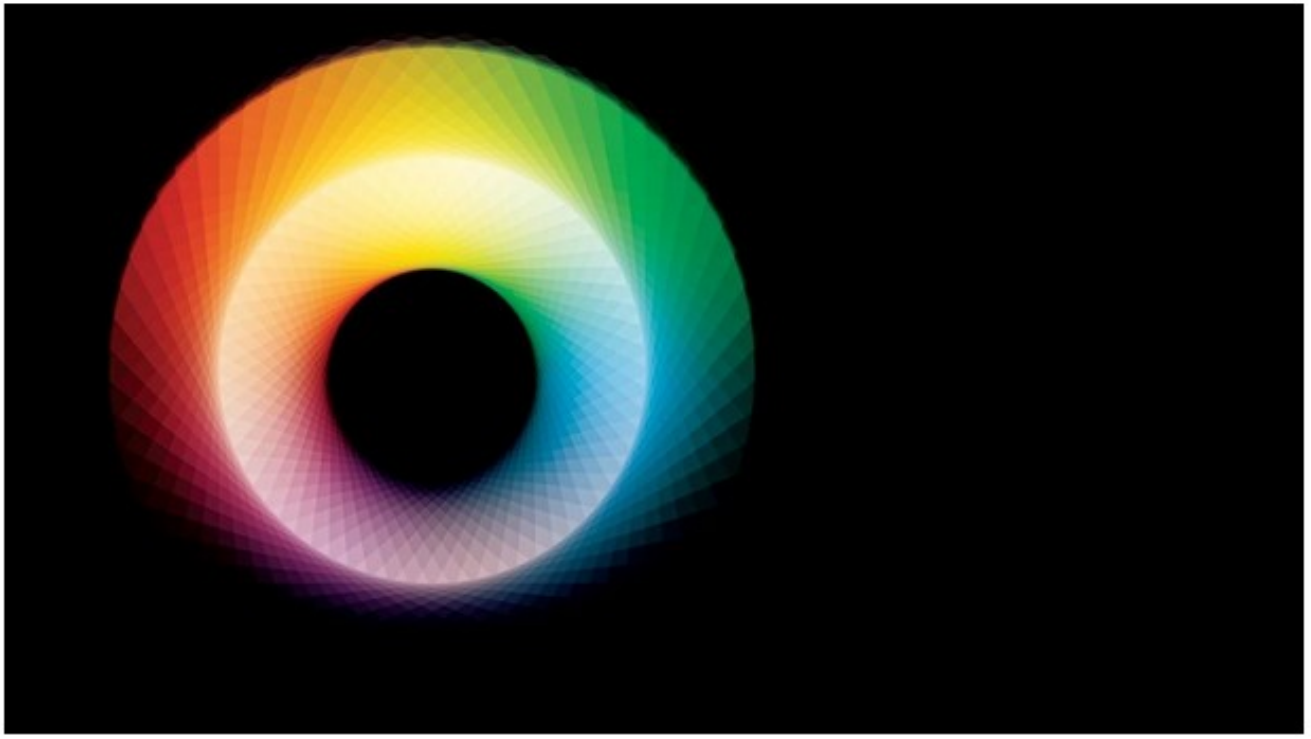
Harvard Business Review

LEADING TEAMS

The New Science of Building Great Teams

by Alex "Sandy" Pentland

FROM THE APRIL 2012 ISSUE



Behavioral Research & Social Signal Processing

"Social signal processing is the new research and technological domain that aims at providing computers with the ability to sense and understand human social signals" (Vinciarelli et al. 2009)

Behavioral cues

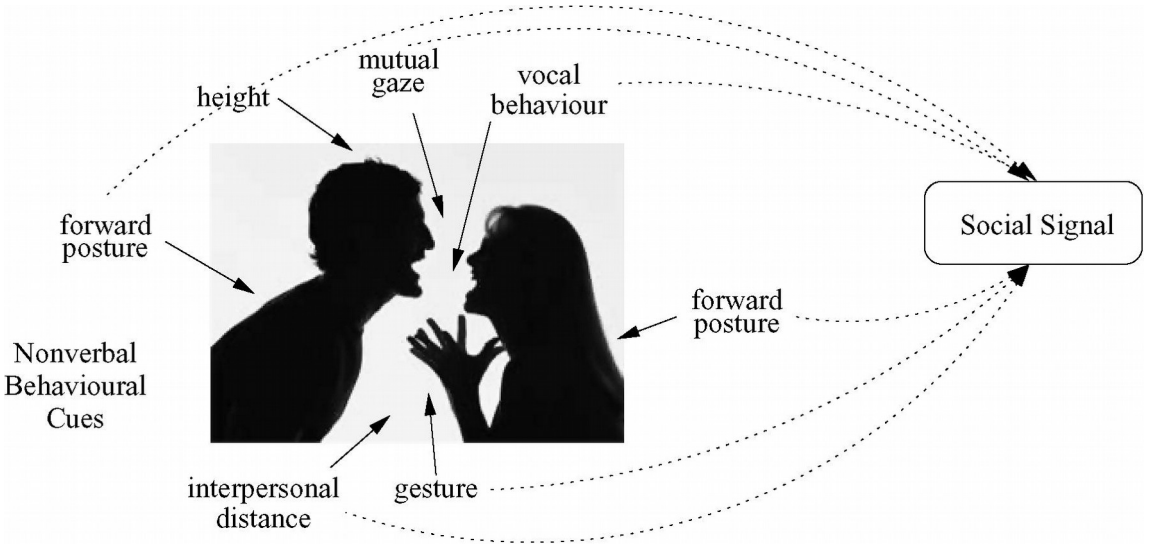
Physical appearance

Gesture and posture

Face & eye behavior

Vocal behavior

Space & environment

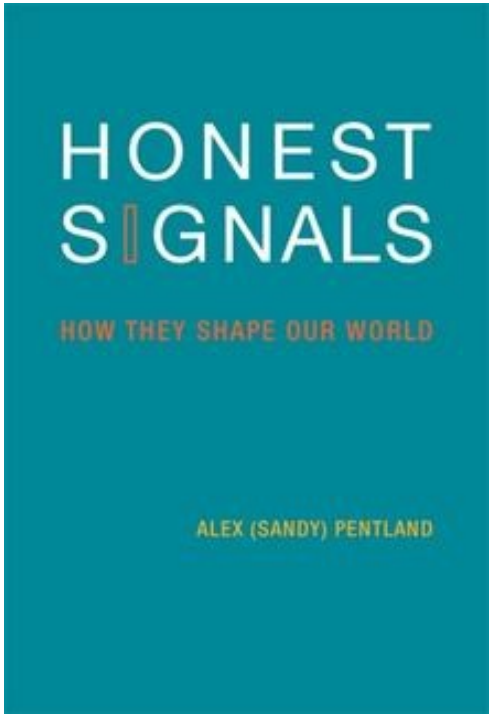


Organizational Research Sensors - MIT

Wearable sensors for organizational research ↔ Smart home or smart textiles, "FitBit" or other medical sensor devices, environmental sensors

Development of "Sociometric Sensors" @ MIT by Sandy Pentland Research Group

"Sensible Organizations: Technology and Methodology for Automatically Measuring Organizational Behavior" (Olguien et al, 2009)



Precise measurement of fundamental layer of human behavior and communication beneath the "surface of words".

(Limitations of) Existing Research

“Honest Signals” - Impressive predictive results based upon quasi-experimental settings

Laboratory validation studies for assessing measurement validity of physical signals
(e.g. Chaffin et al. 2017; Kayhan et al. 2018)

Research in empirical settings – limited to single group scenarios
(e.g. (Matusik et al. 2018; Alshamsi et al. 2016; Blok et al. 2017)

Research Questions

Lack of studies assessing the influence of organizational setting on validity of wearable sensor measurements.

Q1 – To which degree do Bluetooth detects among team members converge with their self-reported friendship ties and advice seeking ties?

Q2 – Does spatial proximity (as measured by Bluetooth) discriminate friends from non-friends and discriminate advice seeking ties?

Q3 – How does organizational context affect the validity of sensor measures?

Methods

9 Case Studies with R&D Teams

Case Study	Country	Field	Organization	Size
1	ES	Biomed. Eng.	University	8
2	ES	Biomed. Eng.	Research Center	10
3	ES	Biomed. Eng.	University	8
4	ES	Biomed. Eng.	Research Center	9
5	ES	Biomed. Eng.	Research Center	11
6	UK	Energy Eng.	University	10
7A	UK	Transport Eng.	Private company	9
7B	UK	Transport Eng.	Private company	7
8	UK	Transport Eng.	Private company	8
				80

Sociometric Badges

Proximity (Bluetooth)
Receive Signal Strength -90 < x < -60. 1-4 meters desirable.

Infrared (f2f)
Cone of 30° angle, 1-1.5 meter. Every 60 seconds.

Audio (speech)
8kHz Volume, voice pitch.

Body movement
Accelerometer energy magnitude.
Sampled 0.1-0.5 seconds

All data timestamped

Field period: sociometric data for each team member collected during 5 working days

Friendship and Advice Seeking

Round-robin scores:

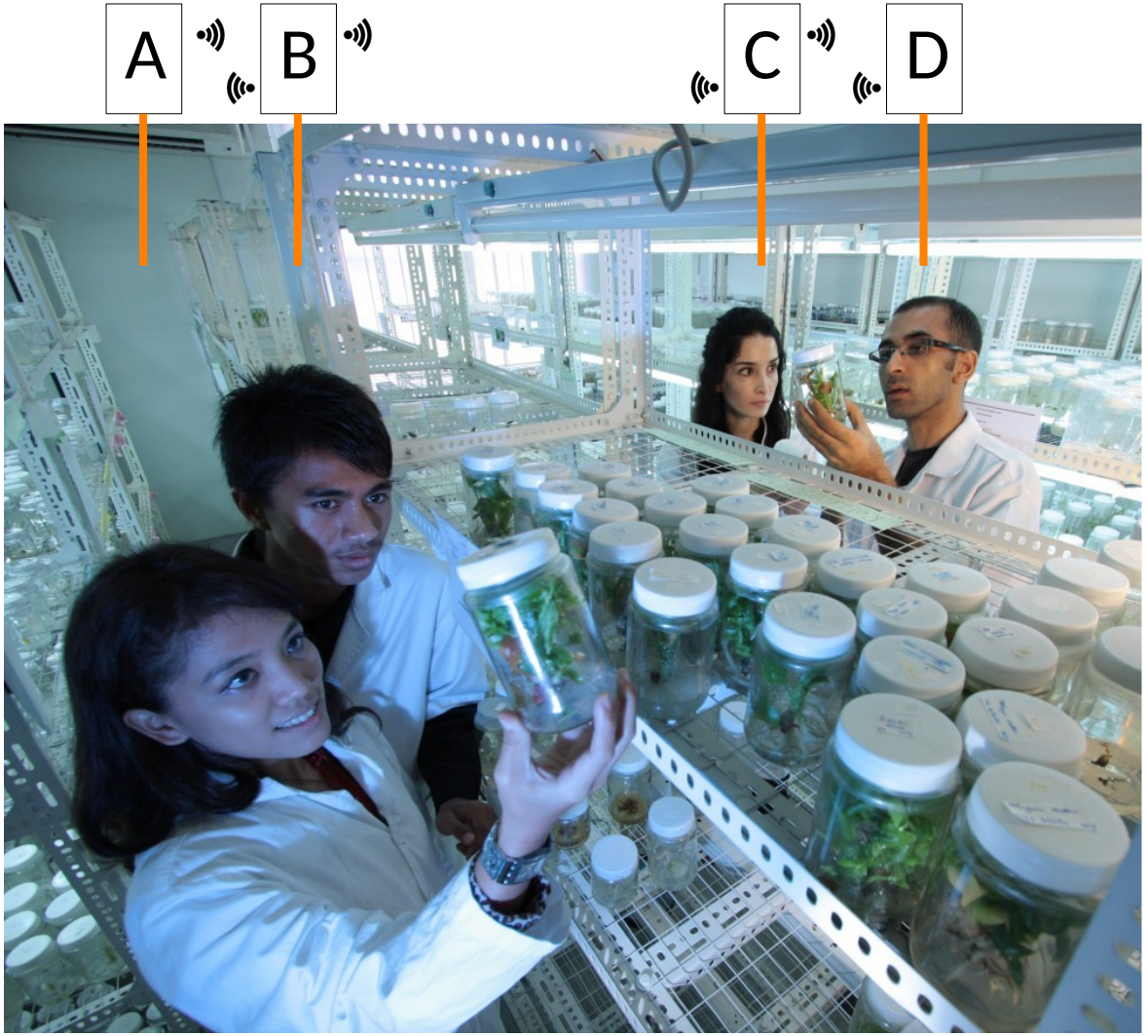
Advice: "Please indicate the frequency with which you ask each of your colleagues for work related advice"
(1=Never, 2=Rarely, 3=Sometimes, 4=Very often, 5=Always)

Friendship: "Please indicate the frequency with which you spend time socially with each of your colleagues outside the lab/office" (1=Never, 2=Some times a year, 3=Some times a month, 4=Some times a week, 5=Daily)

Large body of research corroborating the importance of instrumental and expressive ties in organizations and the workplace
(de Montjoye et al. 2014; Joshi and Knight 2015; Wax, DeChurch, and Contractor 2017; Casciaro and Lobo 2008; Wilkin, Jong, and Rubino 2018)

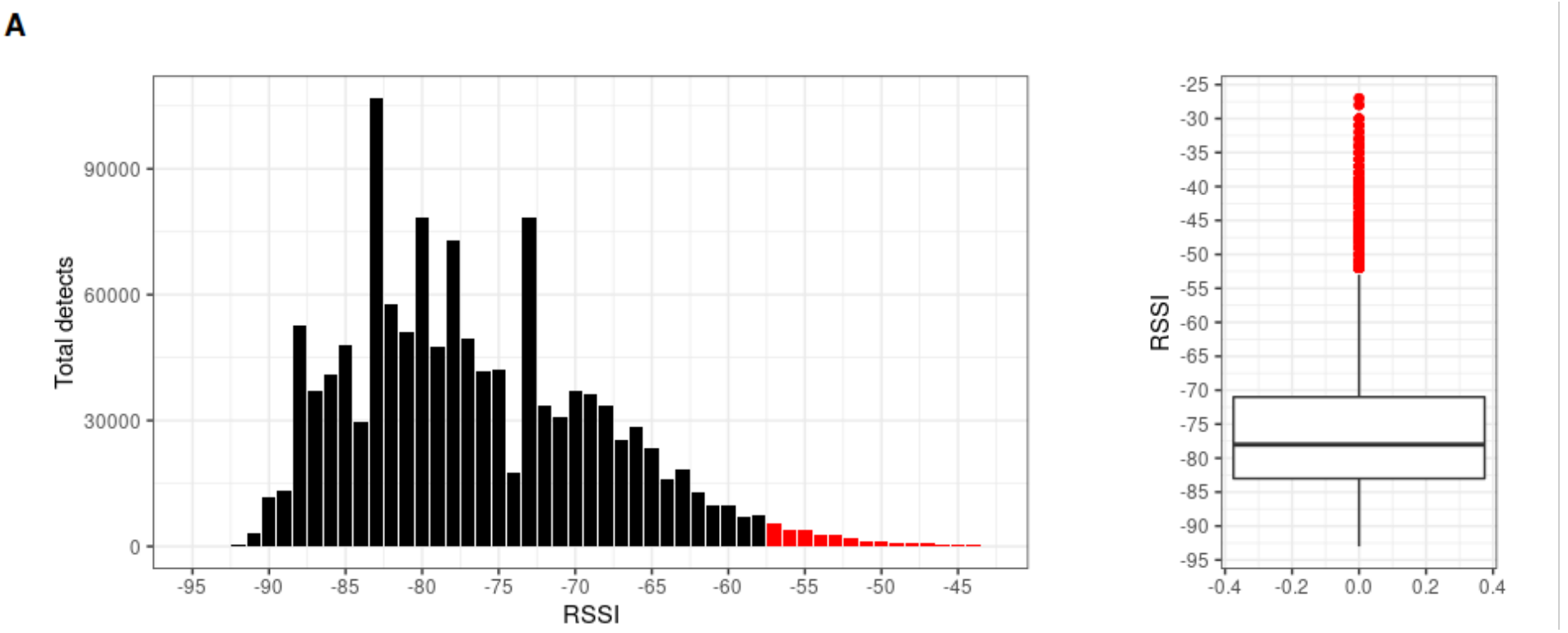
Bluetooth Proximity Measures

Understanding Radio Signal Strength Indicator (RSSI)



Time	ID1	ID2	RSSI
9:01:46	A	B	-54
9:02:01	B	A	-50
9:02:15	B	A	-68
9:03:05	B	C	-78
9:03:22	B	D	-68
9:03:57	A	D	-83
9:04:12	D	C	-56
…	…	…	…

Distribution of RSSI Detects (all 9 teams)



Analytic Approach

General procedure

- Assign unique ID to each team member dyad
- Count BT detects at given RSSI interval or level for each team dyad. (High values such as -52 indicate closer spatial proximity while lower numbers such as -90 indicate greater spatial separation).
- Assign corresponding round-robin scores for each team dyad.
- Calculate Spearman's correlation coefficient *rho* between self-reported ratings and frequency of BT detects for all dyads.

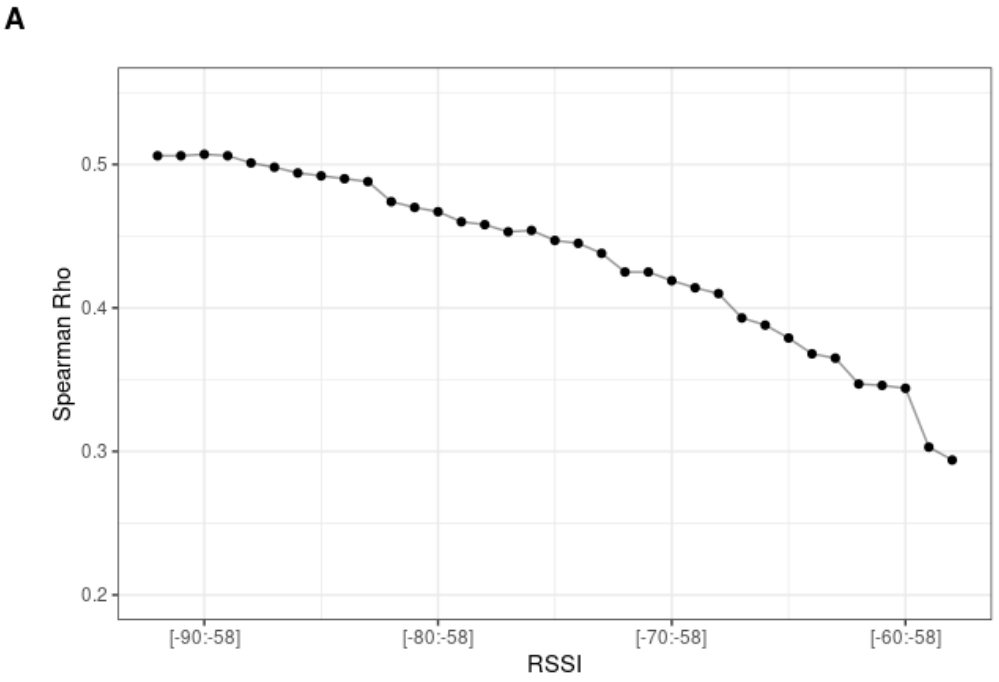
Organizational context

- Subdivide pool of 9 teams into 3 university based teams, 3 research lab teams and 3 private company teams and re-run analysis.

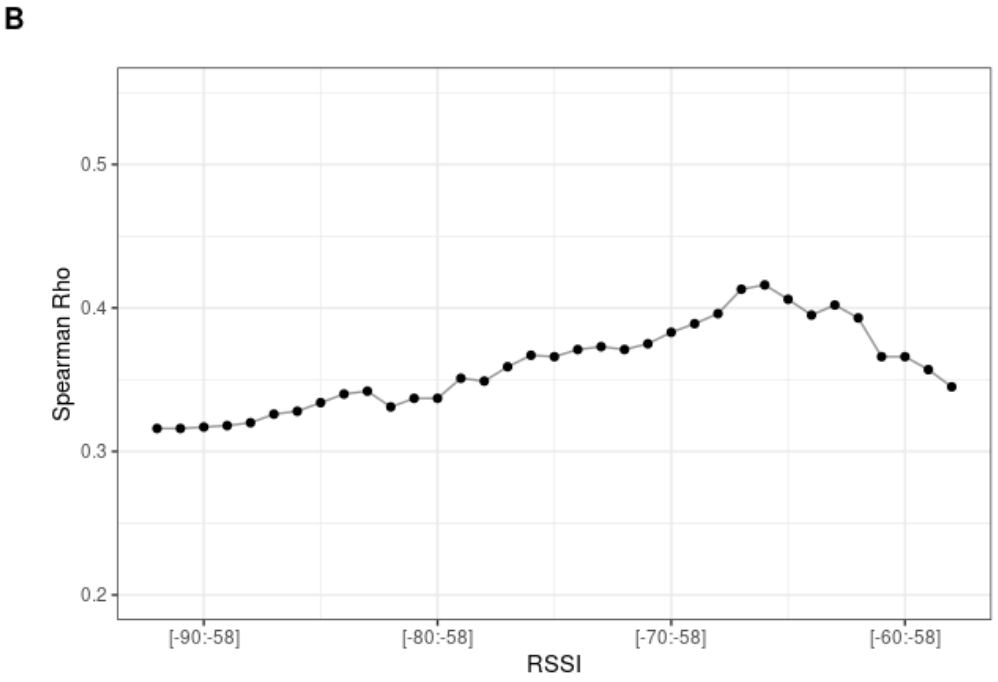
Results

Convergent Validity (all teams)

Friendship

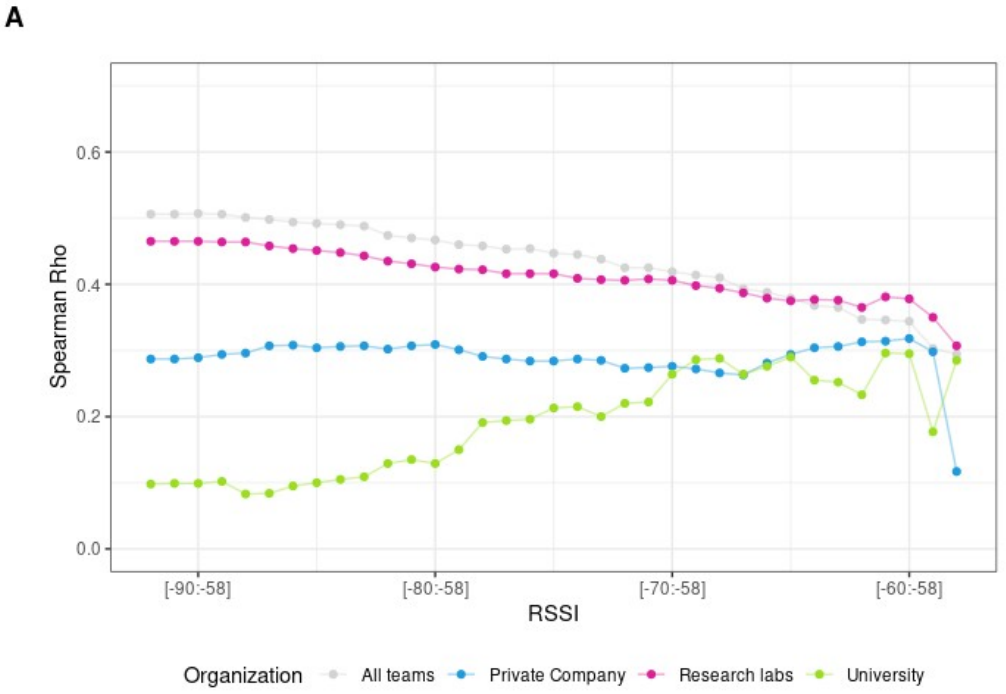


Advice Seeking

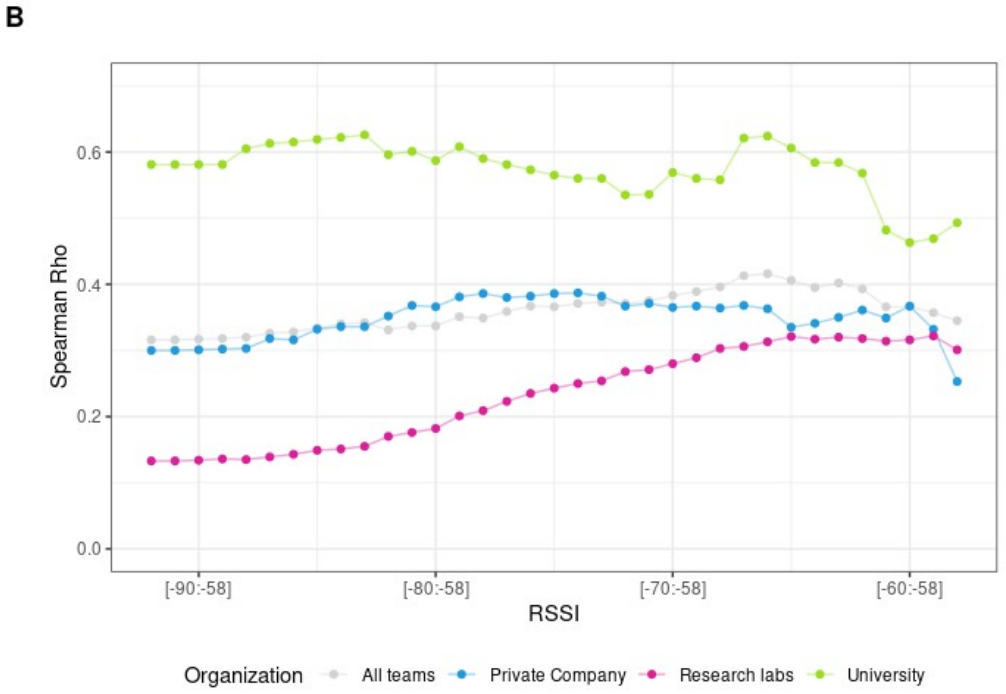


Convergent Validity (organizational context)

Friendship

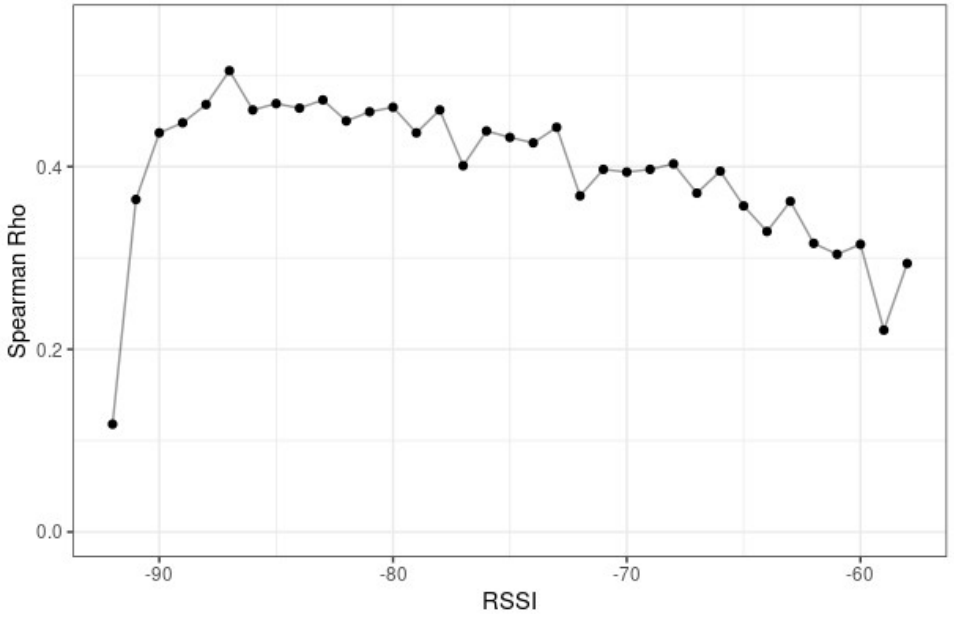


Advice Seeking

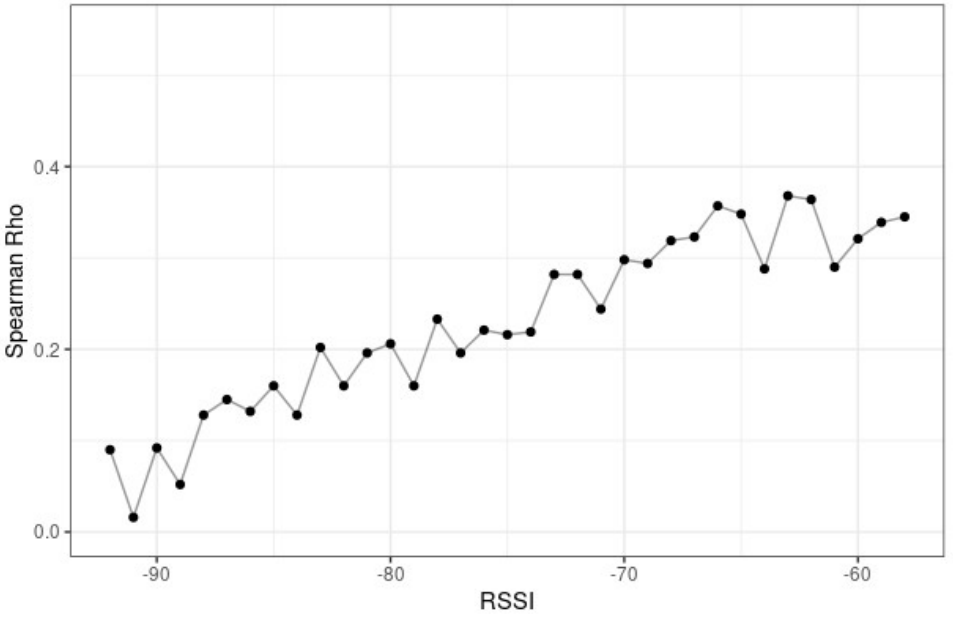


Discriminant Validity (all teams)

Friendship



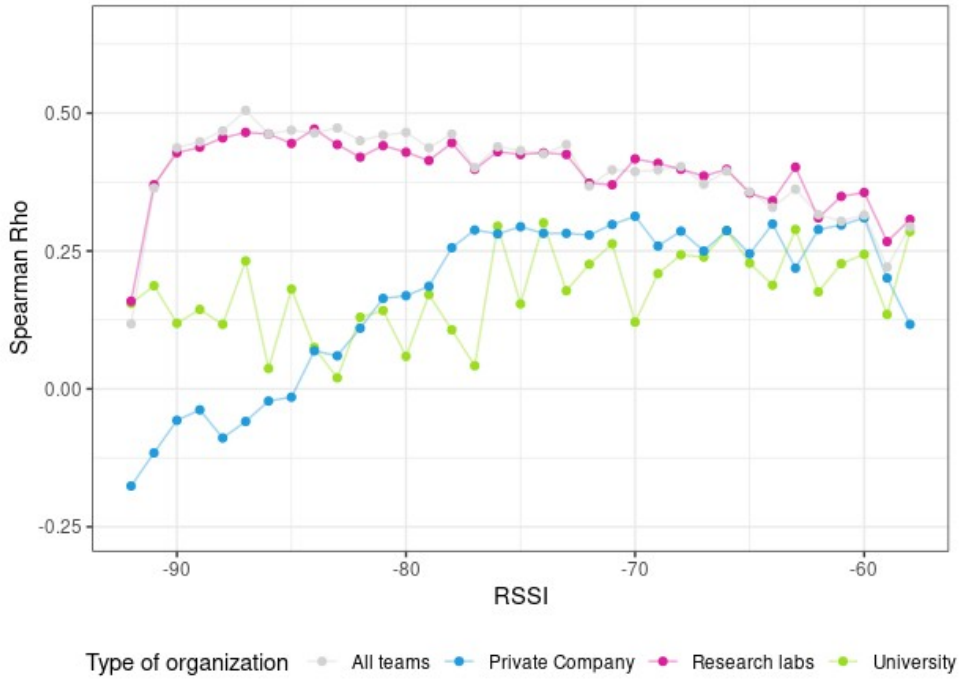
Advice Seeking



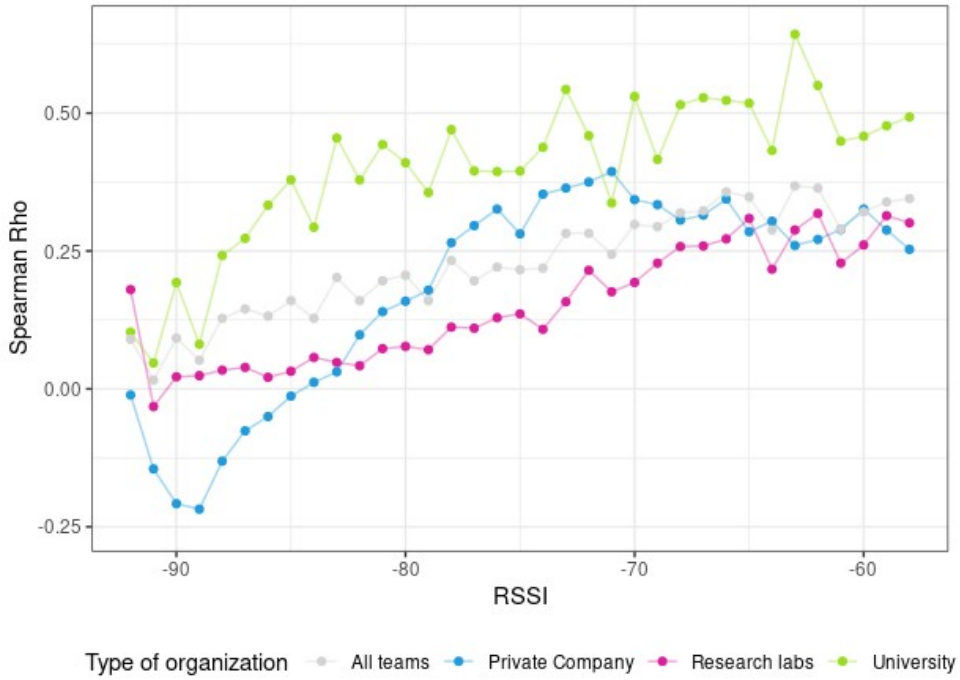
Assess the role of spatial proximity for validity of Bluetooth measures

Discriminant Validity (organizational context)

Friendship



Advice Seeking



Concluding Comments

Bluetooth sensor measures converge to a considerable degree with self-reported instrumental and expressive ties.

BUT: validity of sensor based proximity measures clearly depend on specific organizational contexts!

Consider mixed-methods for collecting complementary data in order to identify genuine social relations within (spatial, organizational) context (see Müller et al. 2019, Doreian & Conti 2012)

→ Opens the path to take advantage of high resolution, temporal interaction data.

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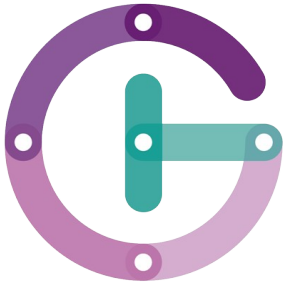
Thank you!



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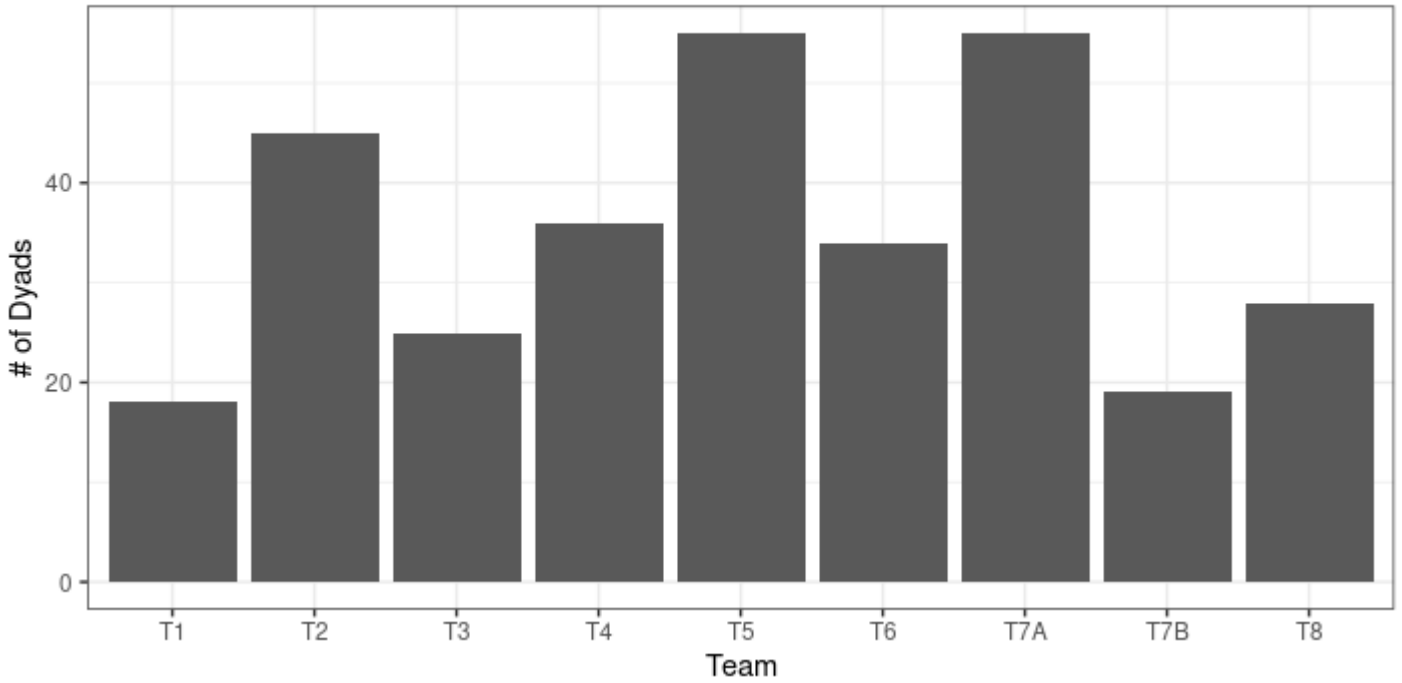
https://www.gender-ict.net

https://www.gedii.eu

https://www.genderportal.eu

https://www.act-on-gender.eu

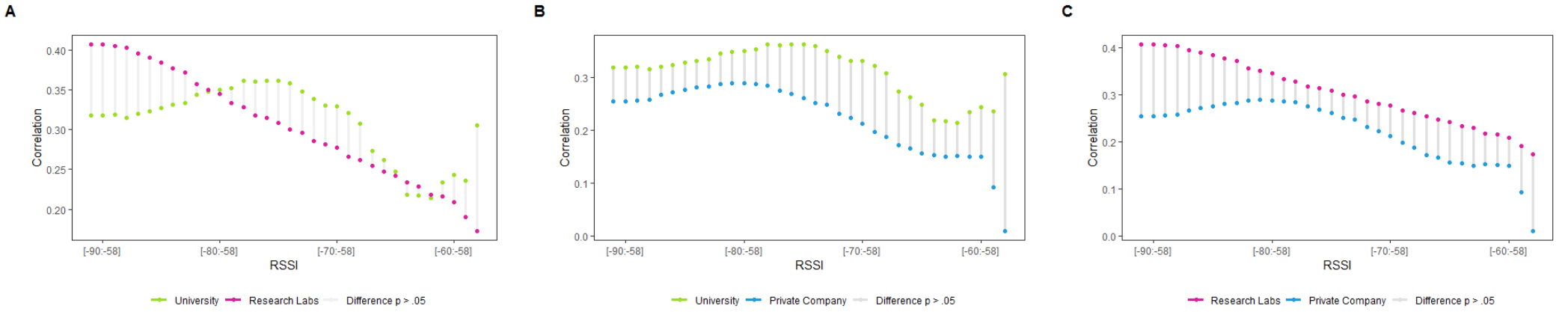
Annex I -



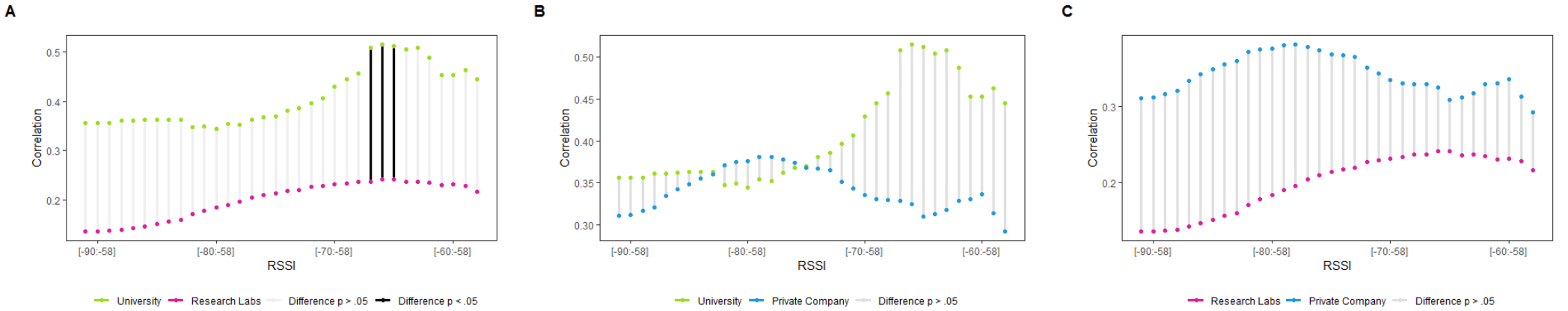
Number of team dyads per team

Cocor – Convergent Validity

Convergent validity. Significant differences between organizational contexts for cumulative BT detects and friendship scores.

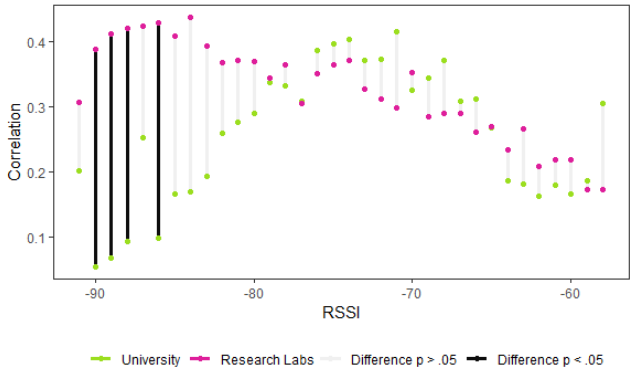


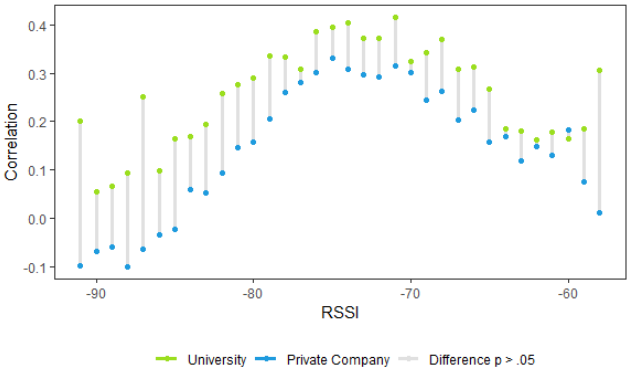
Convergent validity. Significant differences between organizational contexts for cumulative BT detects and advice seeking scores

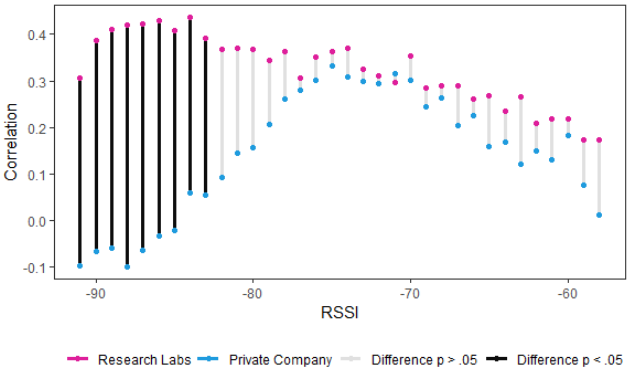


Cocor - Discriminant Validity

Discriminant validity. Friendship correlation coefficients at discrete RSSI levels comparing organizational contexts

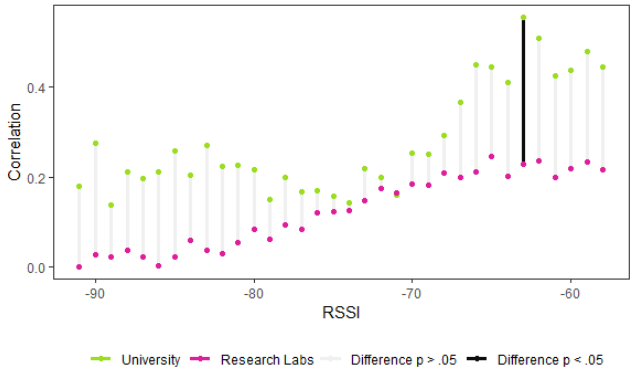






Discriminant validity. Advice seeking correlation coefficients at discrete RSSI levels comparing organizational contexts

A



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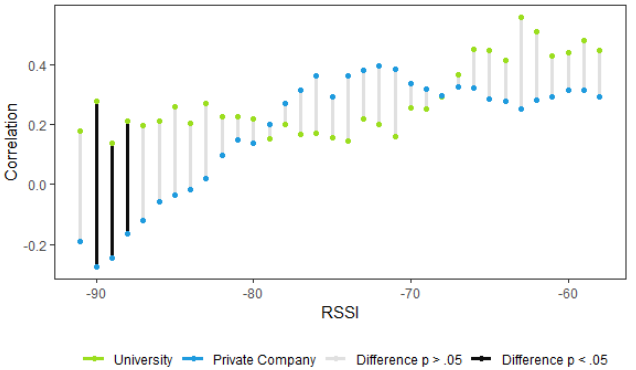

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