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Application of the Network Psychometric Framework to Measurement Burst Designs

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OUTLINE

Network Psychometric framework

(Borsboom et al., 2021; Marsman & Rhemtulla, 2022)

Emerged in the last two decades as an alternative to the latent variable approach based on the concept of the *mutualism model* (van der Maas et al., 2006).

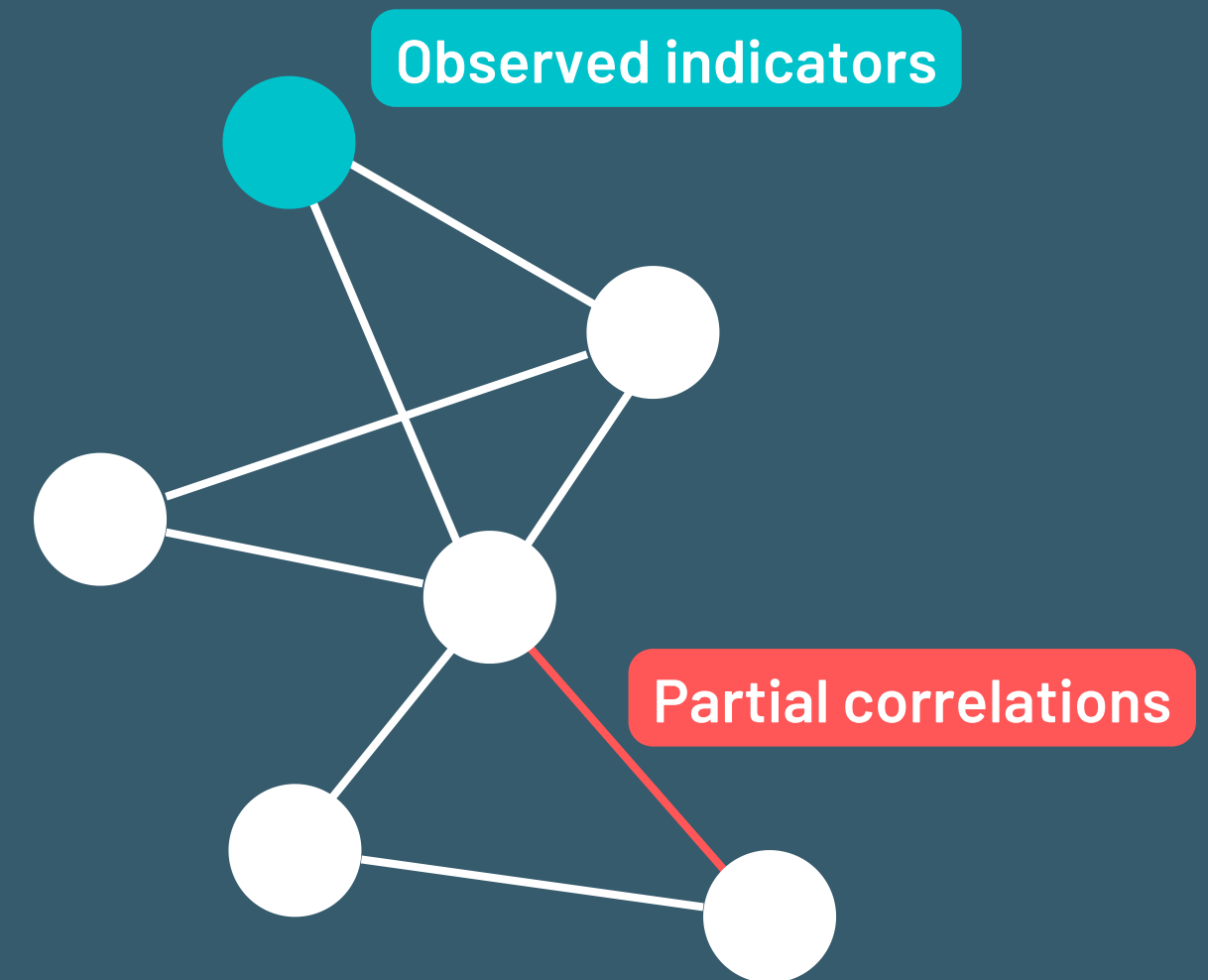
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A psychological process is represented by a network in which **nodes (circles)** are the components of the process, and **lines** represent the **mutual interactions** between pairs of nodes.



OUTLINE

Network Psychometric for **intensive longitudinal designs (ILD)**

(Epskamp, 2020)



$T \geq 5$ + short time-frame (hourly, daily, weekly)
(Bolger & Laurenceau, 2013)

$N > 1$ (nested structure days within people)

The best research design to examine **dynamics of change** of psychological processes in the real life (Boker et al., 2016).

How do the elements of the system fluctuate and influence each other from moment to moment?

Are the process dynamics the same for everyone?

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ILD * $N > 1$ = measurement burst design

Are dynamics of change of the process
stable over time?

OUTLINE

1



(<http://psychonetrics.org/>)

A free and open source R package developed by the psychonetrics lab at the University of Amsterdam (head: Sasha Epskamp) in 2019.

1. Multilevel temporal network for intensive designs

Multilevel ts-lvgvar (Epskamp, 2020)

Multilevel graphical vector-autoregression (mlGVAR) + latent variable modelling (lvm) for time series data with a nested structure (days nested within person).

Based on the **variance decomposition** into a

Within-person variance (encoding dynamics effects)

Between-person variance (encoding individual differences)

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2. Extension for confirmatory hypothesis

GGM + SEM

Fit indices

Parameter significance and constraints

Comparing nested models



APPLICATIVE EXAMPLE

INVESTIGATING DYNAMICS OF CHANGE OF THE PROCESS OF **MEANING-MAKING** IN A DAILY CONTEXT



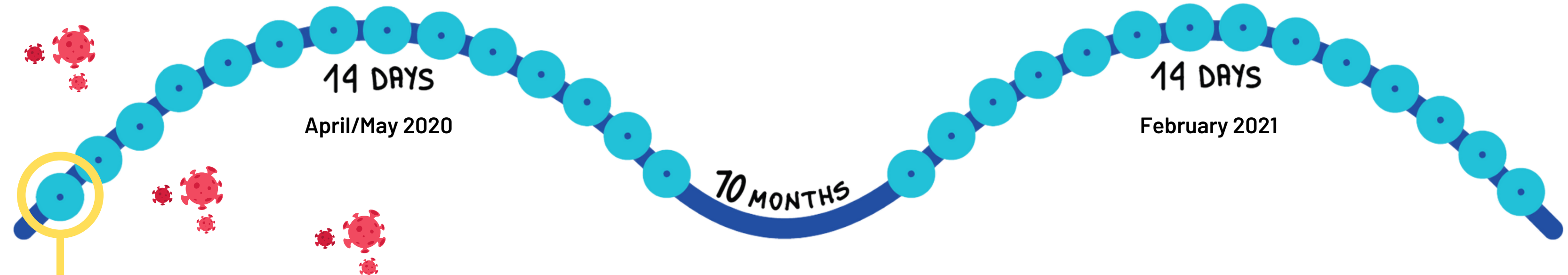
The process by which individuals build the meaning of their life.

The meaning-making process has been conceptualized as a system made of six interacting components (presence of comprehension, search for comprehension, presence of significance, search for significance, presence of purpose, search for purpose).

(Park et al., 2012; Steger et al., 2009; Zambelli & Tagliabue, 2022).

APPLICATIVE EXAMPLE

COVID-19



Measures and Participants

529 Italian emerging and young adults.
WAVE 1 (N=328, 62%)
WAVE 2 (N=347, 66%)
Age 18-37 years (M=25.45; SD=4.04)
69.7% females
43.4% students
34.4% single



SMILE - Situational Meaning in Life Evaluation (Zambelli & Tagliabue, 2022)

Likert scale 1-7. Six items:

1. Presence of coherence (MILPC)
2. Presence of purpose (MILPP)
3. Presence of mattering (MILPM)
4. Search of coherence (MILSP)
5. Search of purpose (MILSP)
6. Search of mattering (MILSM)

"Today, I think I have goals for my life that push me to move forward during the pandemic"

APPLICATIVE EXAMPLE

Multilevel ts-lvgvar (Epskamp, 2020)

What dynamics governed the meaning-making process in the daily context in the first wave?

Observed indicators have been
detrended to respect the stationarity
assumption of VAR models



MODEL FIT: $\chi^2(3570)=32670.5$, $p<.001$; CFI=.89; RMSEA=.053 [.051-.055]; AIC=43859.7; BIC=44175.7

APPLICATIVE EXAMPLE

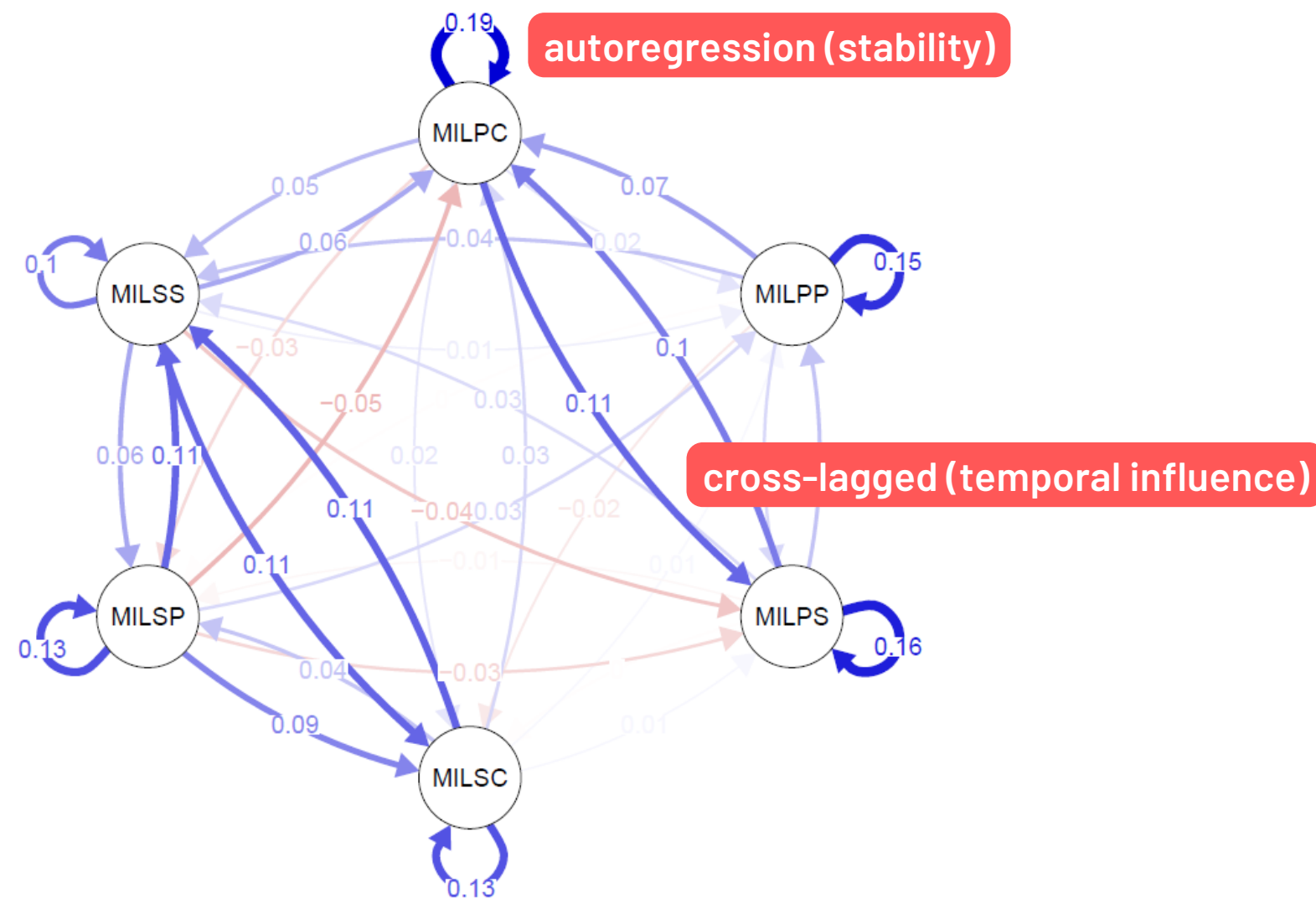
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Temporal network



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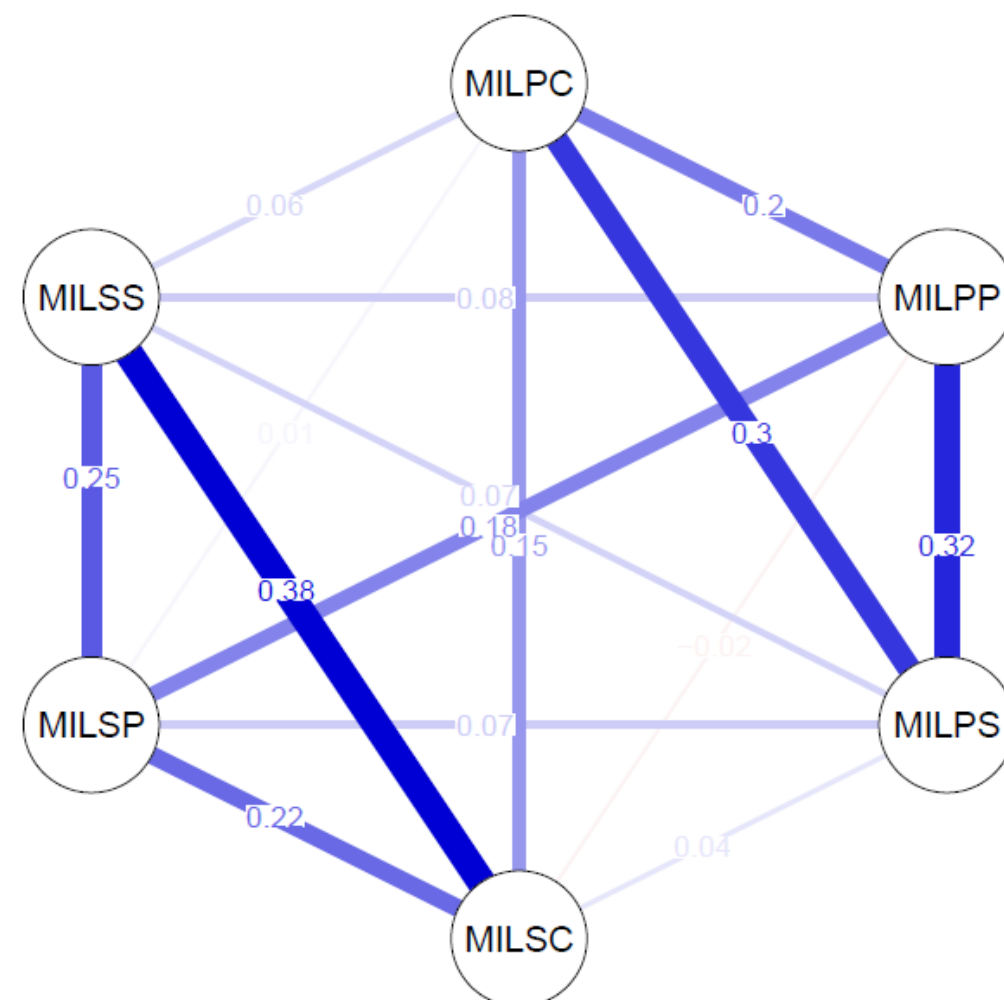
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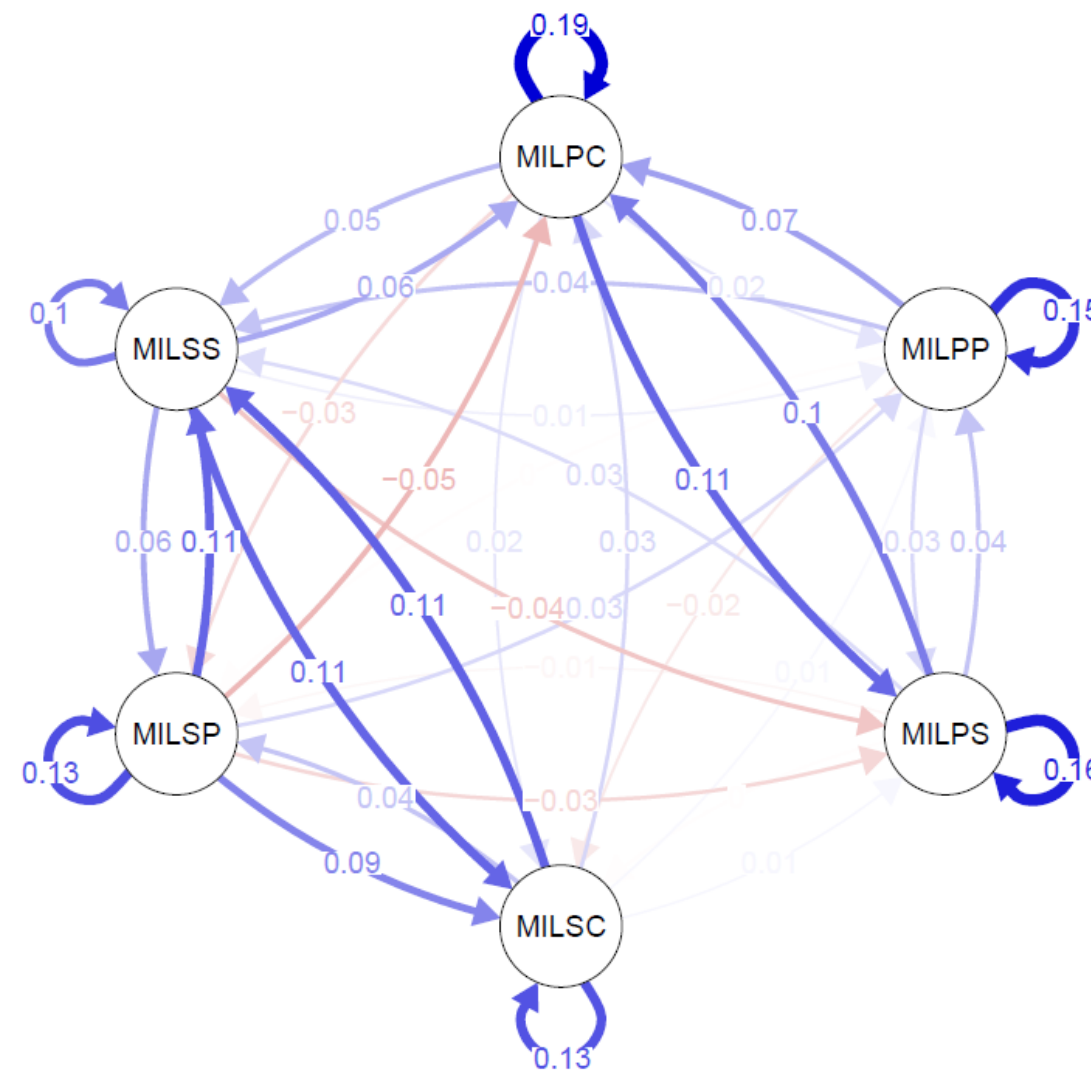
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Contemporaneous Network



Temporal network



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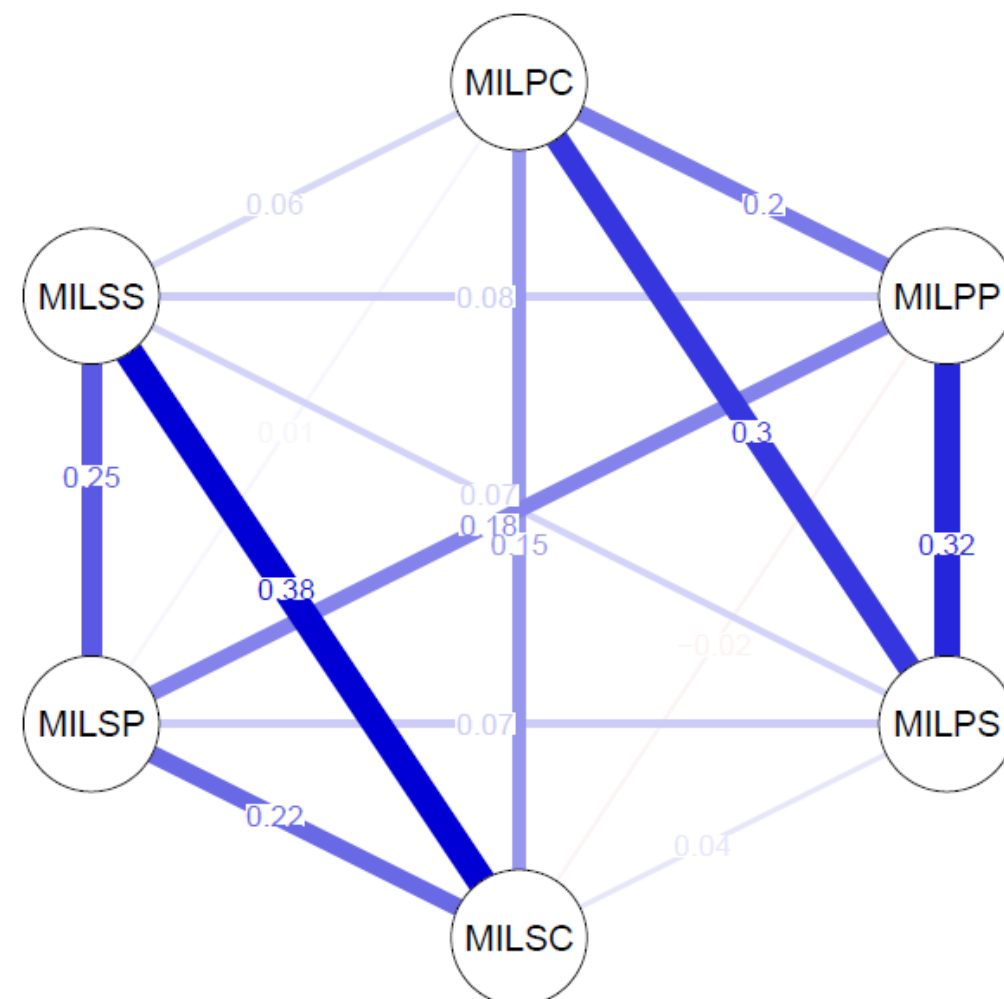
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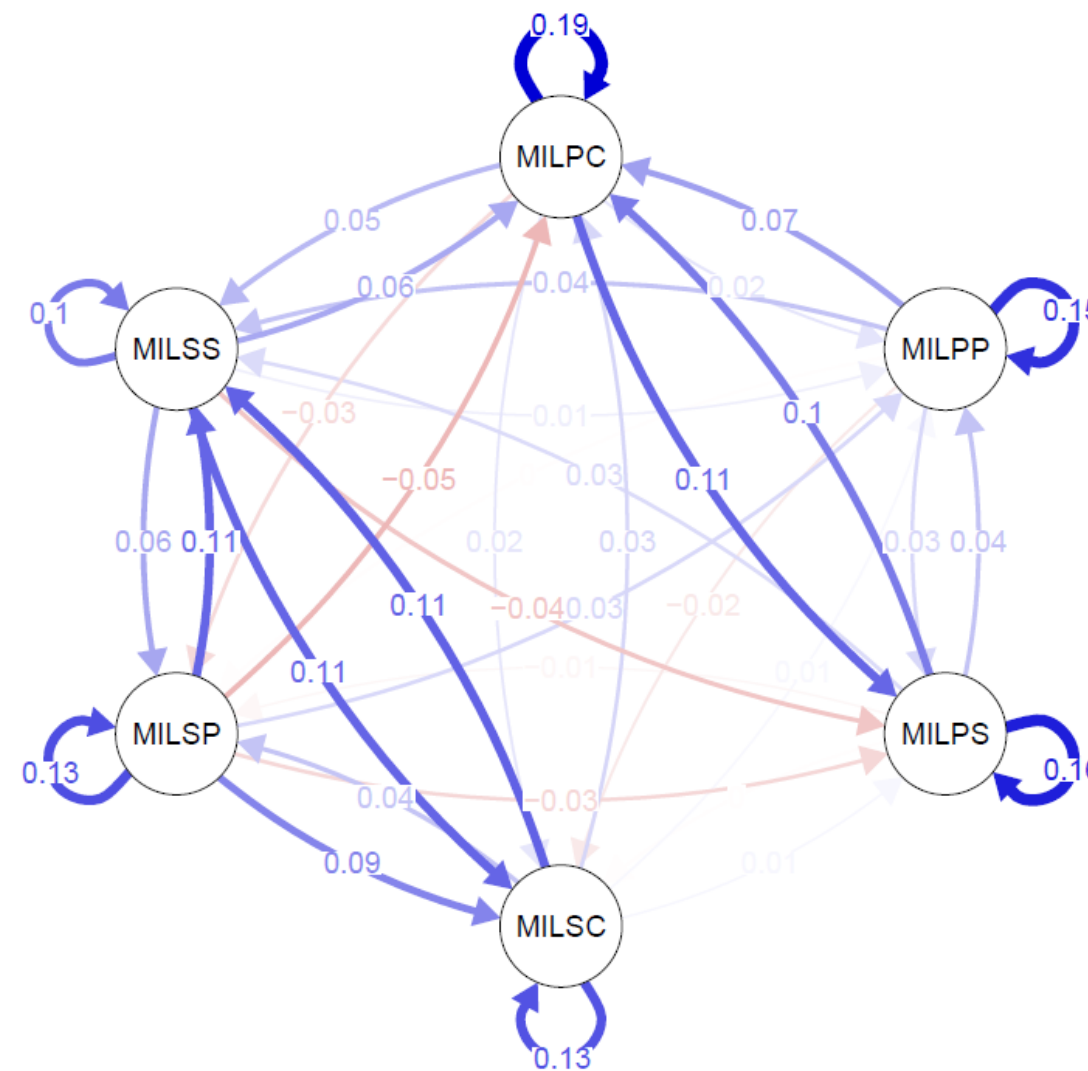
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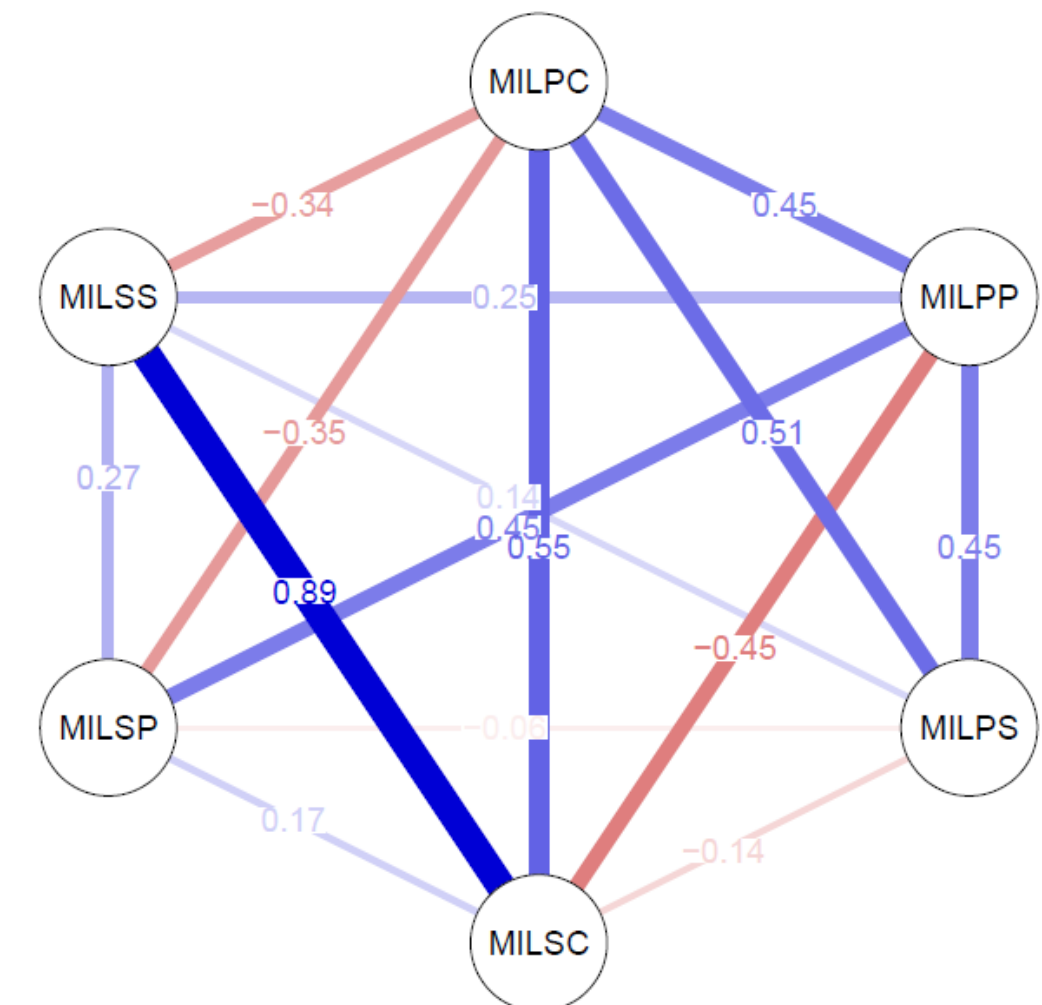
Contemporaneous Network



Temporal network



Between network



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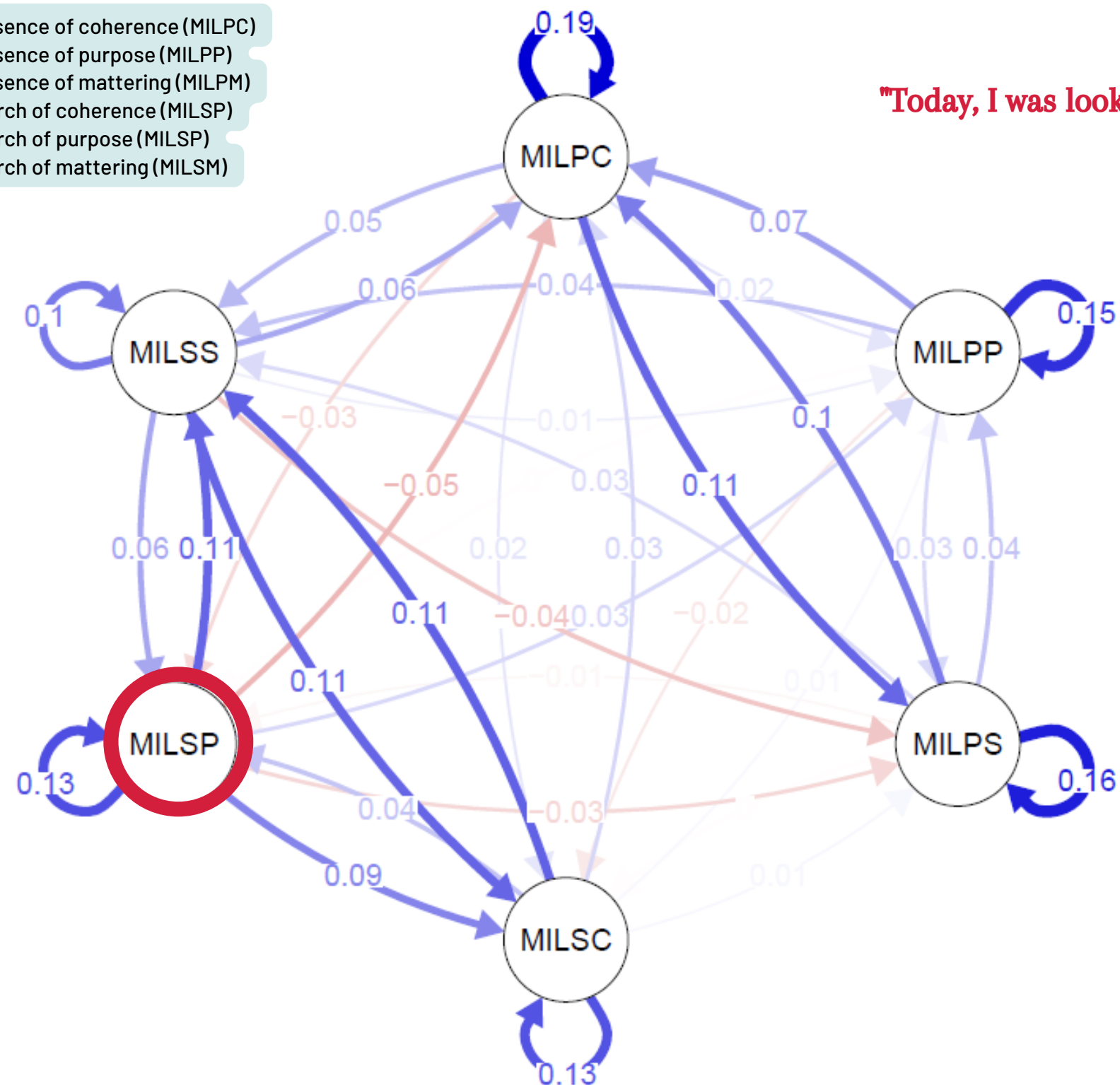
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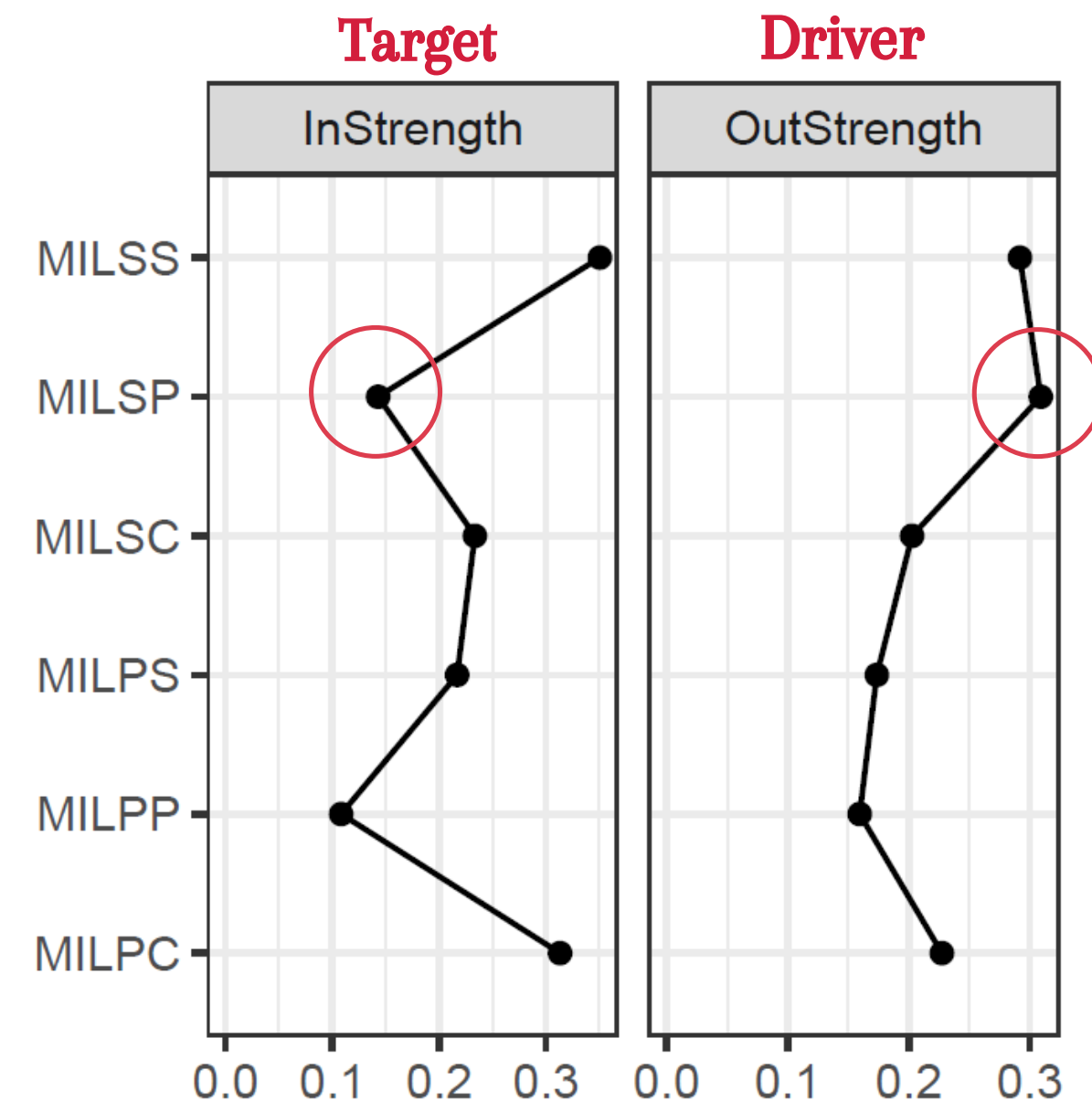


What dynamics governed the meaning-making process in the daily context in the first wave?

Presence of coherence (MILPC)
 Presence of purpose (MILPP)
 Presence of mattering (MILPM)
 Search of coherence (MILSP)
 Search of purpose (MILSP)
 Search of mattering (MILSM)



"Today, I was looking for purposes in my life that push me to move forward during this pandemic situation"



APPLICATIVE EXAMPLE

Multigroup multilevel ts-lvgvar (Epskamp, 2020)

Were the meaning-making process dynamics stable after 10 months?



Table 2. *Model comparison of multi-group network analysis across the two waves*

	χ^2	$\Delta\chi^2$	p	RMSEA	AIC	BIC
Model_free	13029.9 (7140)	-	-	.05	80374.9	81123.9
Contemporaneous_constrained	13326.3 (7155)	296.4	<.001	.05	80641.3	81323.4
Temporal_constrained	13085.2 (7176)	89.2	<.001	.05	80392.1	80980.6
Between_constrained	13077.5 (7155)	47.6	<.001	.05	80392.5	81074.6

χ^2 = Chi-square; $\Delta\chi^2$ = Chi-square difference between nested models; RMSEA=Root Mean Square Error of Approximation; AIC =Akaike Information Criterion; BIC=Bayesian Information Criterion

Only the contemporaneous matrix was non-invariant across the two waves, as constraining the matrices to equality determined an increase of the BIC

MODEL FIT: $\chi^2(7140)= 13029.9$, $p<.001$; CFI=.90; RMSEA=.051 [.049-.052]; AIC= 80374.9; BIC= 81123.9

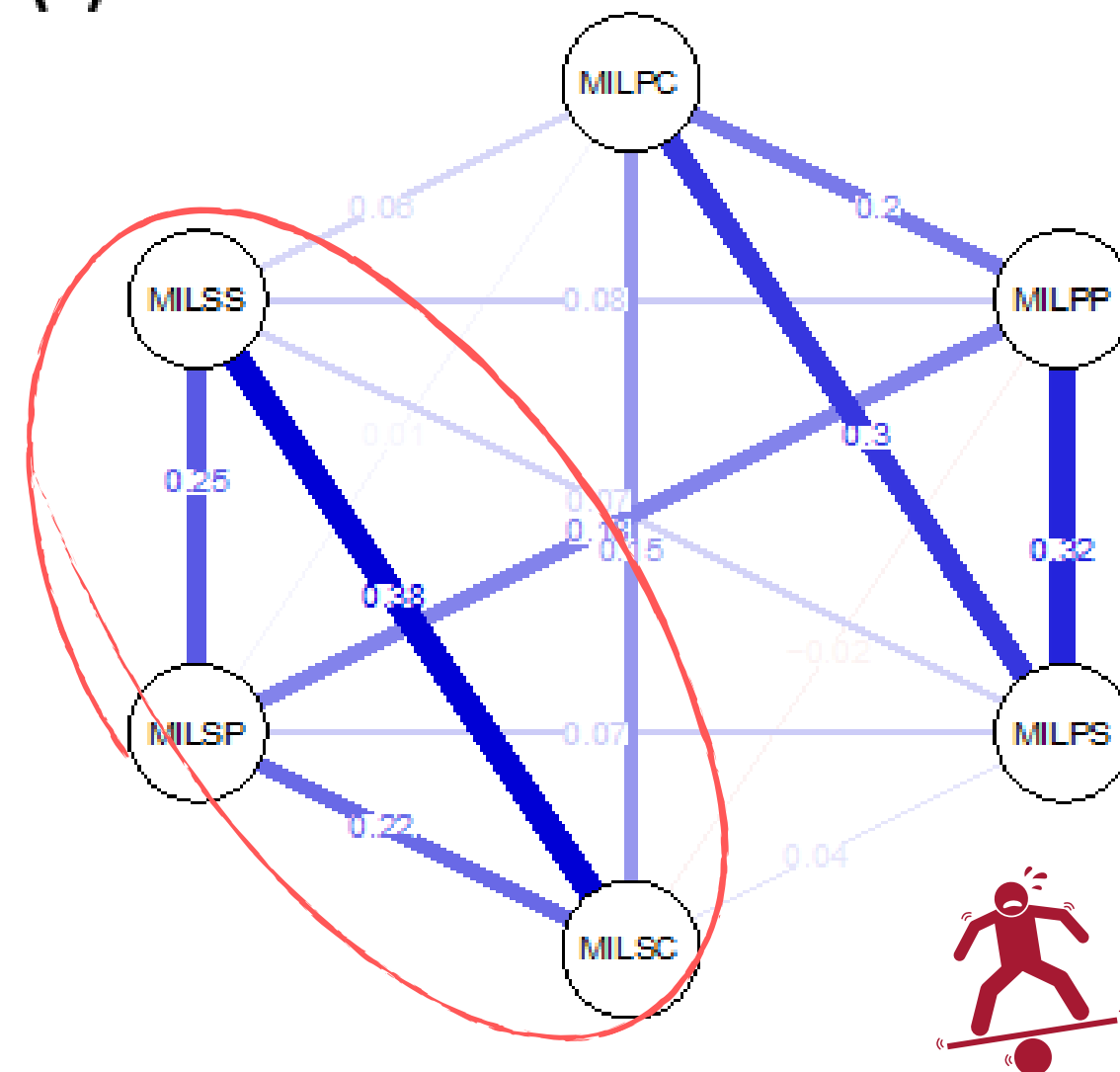
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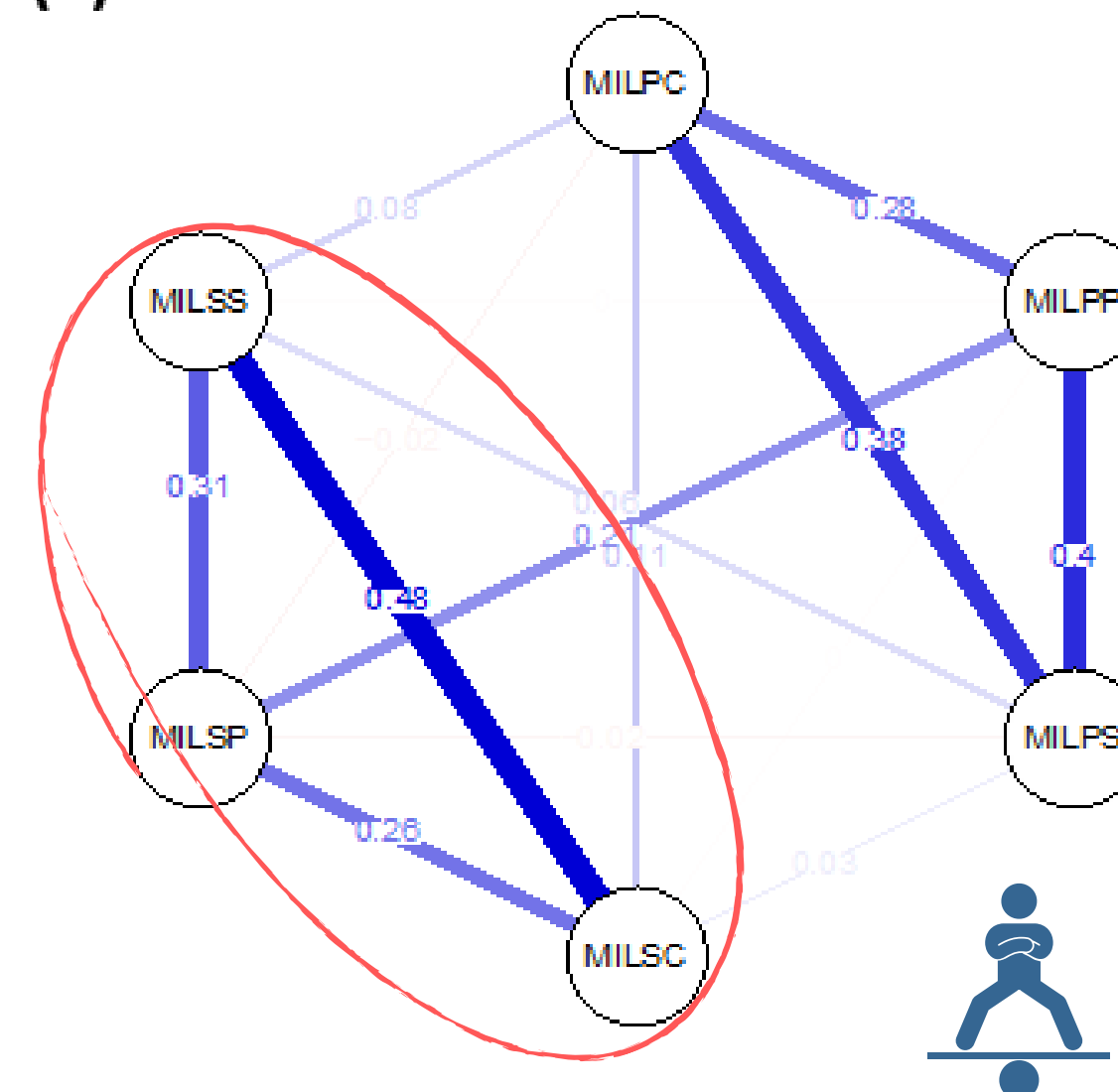
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(a) Wave 1



(b) Wave 2



Young people perceived the three components of presence and search for meaning in a much more similar way on the same day while they were living in a more stable contextual condition (WAVE 2)

CONCLUSIONS



POTENTIALITY OF NETWORK PSYCHOMETRIC FRAMEWORK

1. Network Psychometric is a promising approach to study temporal micro-dynamics at the situational level taking into account the variability between individuals.
2. The psychometrics toolbox extends the primarily exploratory purpose of the network approach by allowing to test confirmatory hypotheses and compare nested models. Empirical proof of the invariance of parameters across groups is possible.
3. Further applications: Replicability and generalizability of process dynamics in different culture, contexts and individual characteristics (e.g., Fried et al., 2018). Application to the evaluation of the effectiveness of interventions (e.g., Ryan & Hamaker, 2022)

CONCLUSIONS



LIMITATIONS

1. Statistical power: our sample was small, both in terms of sample size and number of assessments especially for the multi-group extension.
2. Stationarity assumption: we detrended the six indicators to respect the stationarity assumption of VAR models.
3. Data non-independence: we had to consider the two waves as independent samples to conduct the multi-group comparison. How to manage non-independence in repeated measures designs?

THANKS

THE PRESENTATION WAS BASED ON:

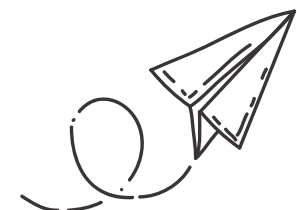
Zambelli, M., Tagliabue, S., & Costantini, G. (2023). Application of the network psychometric framework to measurement burst designs. In Wiberg et al. (in press) (eds) Quantitative Psychology. IMPS 2022. Springer Proceedings in Mathematics & Statistics.



Paper available from January 2023 at the following link:
[IMPS Proceedings – Psychometric Society](#)



Codes and materials available at:
[OSF – Project](#)



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