



# Confirmatory factor Analysis of a French Child-Adapted Questionnaire Assessing Sense of Presence in Virtual Reality



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## Introduction

Virtual reality is increasingly used in clinical psychology and health promotion because immersive environments can elicit emotions, cognitions, and behaviors resembling real-life responses.  
(Malbos & Oppenheimer, 2020; Mouatt et al., 2020; Nolin et al., 2016; Riva, 2022)

A key mechanism supporting VR effectiveness is the **sense of presence** : the subjective illusion of “being there” in the virtual environment while knowing that one is physically elsewhere.  
(Servotte et al., 2020; Slater, 2009; Witmer & Singer, 1998)

## 4 dimensions

Contemporary models distinguish several dimensions:

- Spatial presence** : feeling physically located in the virtual environment.
- Plausibility** : feeling that the events occurring in VR are really happening.
- Social presence** : perceiving another agent as present in the virtual environment.
- Co-presence** : feeling that one shares the same virtual space with another agent.

(Poeschl & Doering, 2015; Slater, 2009; Slater et al., 2022; Youngblut, 2003)

## Need for child-adapted assessment



- Existing tools mostly validated in adults.
- Limited pediatric validation.
- Need to assess distinct dimensions of presence.

(Barešytė et al., 2024; Heck et al., 2021; Schloss et al., 2025)

## Objectives

To examine the factorial structure of a French child/adolescent adaptation of the Presence Self-Assessment Questionnaire, which includes 16 items rated on a 0 - 4 Likert scale and four subscales: Spatial Presence, Plausibility, Social Presence, and Co-presence (Wagener et al., in prep).

### Primary confirmatory factor analysis

The hypothesized model was a correlated four-factor structure including: Spatial Presence, Plausibility, Social Presence, Co-presence.

### Model comparison

Because Social Presence and Co-presence are theoretically close dimensions, and because their distinction may rely on socio-cognitive abilities still developing during childhood, the four-factor model was compared with a more parsimonious three-factor model combining these two social dimensions.

(Biocca et al., 2003; Bulu, 2012; Gabriel et al., 2021; Meinhardt-Injac et al., 2020; Peterson & Wellman, 2019)

## Sample & Descriptive Results

**Participants:** 325 children, aged 8 to 15 years ( $M = 10.64$ ;  $SD = 1.96$ ), recruited from the general population.

### Descriptive Results by Age Group and Gender

|                         | Total<br>$N = 325$<br>$m(SD)$ | 8 - 11 y/o<br>$N = 238$<br>$m(SD)$ | 12 - 15 y/o<br>$N = 87$<br>$m(SD)$ | Wilcoxon<br>$W(p)$ | Girls<br>$N = 165$<br>$m(SD)$ | Boys<br>$N = 160$<br>$m(SD)$ | Wilcoxon<br>$W(p)$ |
|-------------------------|-------------------------------|------------------------------------|------------------------------------|--------------------|-------------------------------|------------------------------|--------------------|
| <b>Spatial presence</b> | 2.86 (0.95)                   | 2.94 (0.97)                        | 2.63 (0.87)                        | 7939<br>(.001)     | 2.98 (0.88)                   | 2.73 (1)                     | 11344<br>(.028)    |
| <b>Plausibility</b>     | 2.26 (1.18)                   | 2.42 (1.2)                         | 1.83 (1)                           | 7219<br>(<.001)    | 2.51 (1.16)                   | 2.01 (1.15)                  | 9938<br>(<.001)    |
| <b>Social presence</b>  | 2.41 (1.01)                   | 2.54 (1.04)                        | 2.06 (0.83)                        | 7272<br>(<.001)    | 2.56 (0.93)                   | 2.26 (1.08)                  | 11116<br>(.014)    |
| <b>Co-presence</b>      | 2.36 (1.01)                   | 2.48 (1.01)                        | 2.03 (0.94)                        | 7753<br>(<.001)    | 2.5 (0.96)                    | 2.22 (1.04)                  | 11315<br>(.026)    |

Younger children and girls reported higher presence scores across all subdimensions. Younger children’s higher scores may reflect the fairy-tale and playful content of the virtual environment, whereas girls’ higher scores may reflect greater engagement with its relaxing, narrative, and emotionally guided features of the virtual environment.

(Sanchis-Sanchis et al., 2020; Stassart et al., 2026)

### Age effect

8 - 11 y/o > 12 - 15 y/o on all 4 subdimensions



### Gender effect

Girls > Boys on all 4 subdimensions

## Method & Procedure



### Pre-immersion

#### Pre-immersion Questionnaires :

Anxiety - STAIC (Spielberger et al., 1973; French version: Turgeon & Chartrand, 2003).

Cybersickness - SSQ (Kennedy et al., 1993; French adaptation: St-Jacques, 2007).



### VR immersion

#### VR immersion :



Children were immersed, using an HMD headset, in a relaxing environment. Guided by a fairy, they navigated a boat through a forest, accompanied by a fox, while completing breathing exercises in a soothing soundscape. The immersion lasted approximately 7 minutes.

This VR relaxation environment had been previously validated in children, reducing state anxiety (Stassart et al., 2026).

#### Post-immersion Questionnaires :

Sense of Presence

Anxiety - STAIC

Cybersickness - SSQ

Satisfaction with the experience

## Confirmatory Factor Analysis Results

### Standardized factor loadings

| Factor                  | $\lambda$ range |
|-------------------------|-----------------|
| <b>Spatial Presence</b> | .77 - .84       |
| <b>Plausibility</b>     | .82 - .90       |
| <b>Social Presence</b>  | .64 - .82       |
| <b>Co-presence</b>      | .71 - .82       |

All standardized loadings were substantial and statistically significant ( $p < .001$ ).

### Latent Factor Correlations

All correlations were positive and high:  $\varphi = .73 - .97$ ,  $p < .001$

Strongest correlation: Social Presence ↔ Co-presence:  $\varphi = .97$ ,  $p < .001$ .

### Model comparison

Estimator: WLSMVS, based on polychoric correlations.

| Model                               | $\chi^2(df)$ | CFI  | TLI  | RMSEA [90% CI]     | SRMR | Decision            |
|-------------------------------------|--------------|------|------|--------------------|------|---------------------|
| <b>Four-factor correlated model</b> | 186.76 (46)  | .924 | .987 | .097 [0.081, .114] | .043 | <b>Retained</b>     |
| <b>Three-factor model</b>           | 190.64 (47)  | .922 | .987 | .097 [0.082, .113] | .045 | <b>Not retained</b> |

The two models showed virtually identical fit: CFI, TLI, and RMSEA differed only marginally, and the four-factor model showed a slightly lower SRMR (.043 vs. .045). Fit was nonetheless mixed in absolute terms: CFI (.92) fell below the conventional .95 threshold and RMSEA (.097) approached the cutoff for poor fit (.10), while TLI (.99) and SRMR indicated good fit. Given this near-equivalence, the four-factor model was retained primarily because it aligns with the theoretical distinction between the four presence dimensions. An overall presence score can also be used as a reliable composite indicator, as the global 16-item scale showed excellent internal consistency ( $\omega = .97$ ).

### Key finding

The retained model supports a multidimensional interpretation of sense of presence, with four correlated subdimensions and a global presence composite score. The strong overlap between Social Presence and Co-presence does not necessarily mean these dimensions should be merged. It more likely reflects two complementary factors: ongoing socio-cognitive development, which is especially relevant given that most participants were aged 8 - 11, and the limited social interactivity of the virtual environment, which involved a guiding fairy and a passive companion rather than richer, reciprocal interactions.

## Conclusion

These CFA findings provide preliminary support for the structural validity of the French child/adolescent adaptation of the Presence Self-Assessment Questionnaire. The four-factor model was retained because it showed slightly more favorable fit than the three-factor alternative and remained more consistent with multidimensional theories of presence. Although Social Presence and Co-presence were strongly correlated, this overlap may reflect two complementary factors: ongoing socio-cognitive development, especially in younger children, and the limited social interactivity of the virtual environment. A four-factor scoring solution is therefore recommended to preserve the conceptual richness of the construct, while interpreting the two social dimensions cautiously. In addition to the four subscale scores, an overall presence score can be used as a composite indicator. Future studies should replicate these findings in independent samples and in virtual environments with richer social interactions. Given that children aged 8 - 11 represented 73% of the present sample, future work should also test measurement invariance across age groups, and more generally examine the questionnaire’s test-retest reliability. Overall, these findings represent a first step toward a psychometrically sound tool for assessing presence in children and adolescents, supporting more rigorous evaluation of VR-based interventions in pediatric research and clinical practice.



Scan for full references

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