

Age-Differentiated Pathways to Privacy Protection in Smart Voice Assistants

A multigroup PLS-SEM study of youth (Canada, ages 16–24)

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Smart voice assistants (SVAs) change the privacy surface

- Always-on voice interfaces blur active use vs. passive collection
- Data may include voice inputs, transcripts, and contextual metadata
- Youth face complex decisions, often with limited visibility and control

Developmental + household context

- 16–18: more household-mediated setup and defaults
- 19–24: more autonomy and digital self-management
- Privacy perceptions and risk/benefit trade-offs evolve with age

Research gap

Most prior SVA privacy studies treat “youth” as a single group.

This work tests whether the pathways to privacy-protective behavior differ between 16–18 and 19–24.

RQ1: Mean differences by age

Do 16–18 vs. 19–24 differ in PPR, PPBf, ATT, PSE, and PPB?

RQ2: Pathway differences by age (MGA)

Are structural relationships among constructs different across age groups?

RQ3: Developmentally sensitive leverage points

Which pathways change with age, and what does that imply for privacy-by-design?

Contributions

- Multigroup PLS-SEM with MICOM invariance checks
- Separates age effects on baseline perceptions vs. behavioral mechanism
- Translates results into age-appropriate SVA privacy design guidance

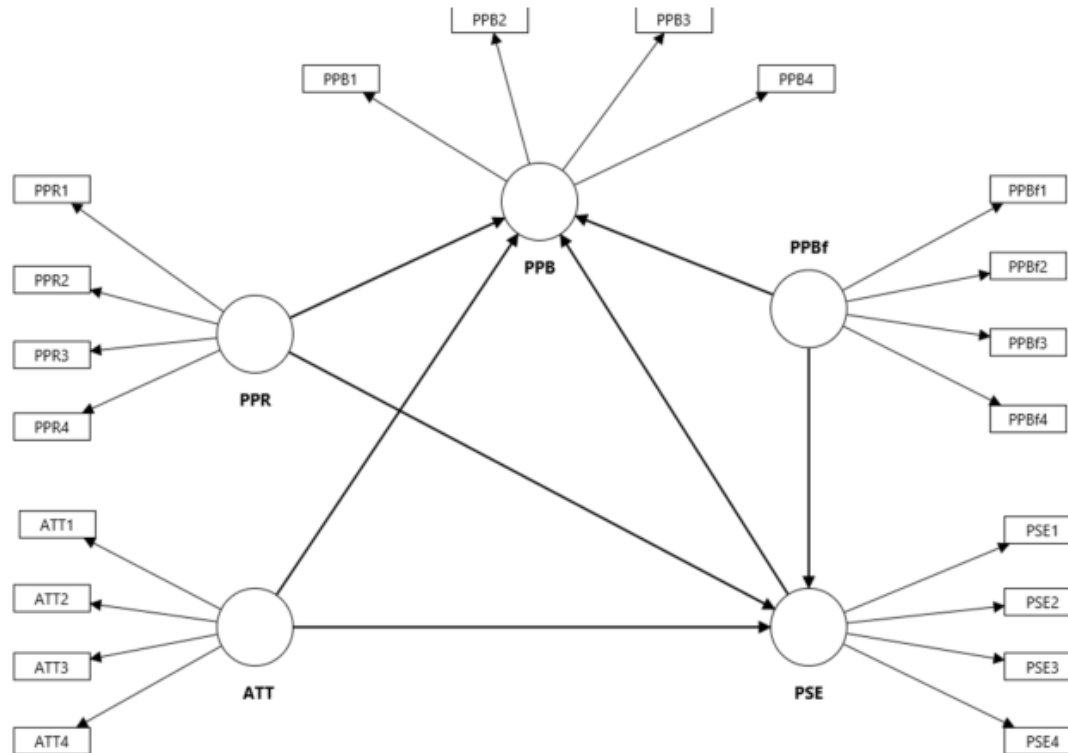


Fig. 1. Conceptual model.

Constructs

- PPR: perceived privacy risk
- PPBf: perceived privacy benefits
- ATT: algorithmic transparency & trust
- PSE: privacy self-efficacy (mediator)
- PPB: privacy-protective behavior (outcome)

Key premise: building confidence to act (PSE) drives protective behavior (PPB).

Participants & data collection

- Canada, ages 16–24; online survey (Microsoft Forms)
- Valid responses after cleaning: N = 412
- Younger: 16–18 (n=245) • Older: 19–24 (n=167)
- Ethics approval: VIU-REB #103597

Analysis pipeline

- PLS-SEM model estimated per age group
- Measurement invariance (MICOM) before comparisons
- Permutation-based multigroup analysis (1,000 permutations)
- Focus: 7 direct paths among 5 constructs

Sample snapshot (Table III)

TABLE III. PARTICIPANT DEMOGRAPHICS

Characteristic	Age Group 16-18		Age Group 19-24	
	<i>n</i>	%	<i>n</i>	%
Gender				
Female	86	35.1	67	40.1
Male	134	54.7	85	50.9
Non-binary/Other	7	2.9	7	4.2
Prefer not to say	16	6.5	7	4.2
Blank/Missing	2	0.8	1	0.6
Education Level				
High School	214	87.3	24	14.4
Post-Secondary	25	10.2	143	85.6
Blank/Missing	6	2.4	0	0
Frequency of SVA use				
Daily	65	26.5	44	26.3
Monthly	21	8.6	11	6.6
Rarely	97	39.6	71	42.5
Weekly	61	24.9	41	24.6
Blank/Missing	1	0.4	0	0
	Mean (SD)		Mean (SD)	
Age	16.98 (0.62)		21.10 (1.55)	

Why it matters

- Before comparing path coefficients, constructs must be comparable across groups
- MICOM Step 2 (compositional invariance) determines if MGA is appropriate
- Here: compositional invariance supported for all five constructs

Practical interpretation

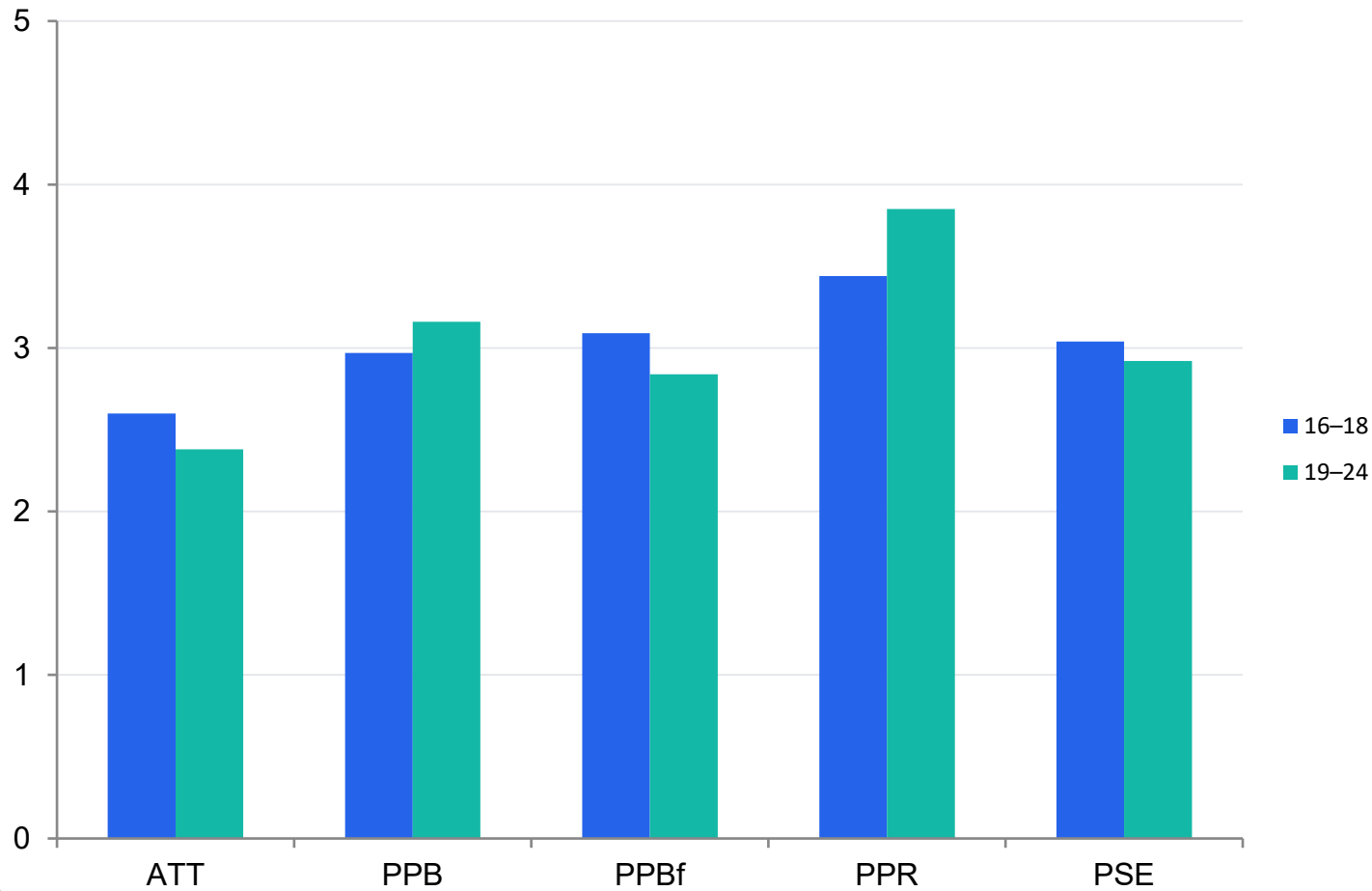
- Step 3 shows partial invariance (means/variance not always equal)
- Comparing paths remains valid under MICOM when Step 2 holds
- Takeaway: proceed to MGA for developmentally sensitive pathways

MICOM summary (Table V)

TABLE V. MEASUREMENT INVARIANCE OF COMPOSITE MODELS

Construct	Composite (Step 2)			
	Correlation value	5% Quintile	p	Composite Invariance
ATT	0.987	0.949	0.373	Yes
PPB	0.999	0.970	0.884	Yes
PPBf	0.999	0.992	0.578	Yes
PPR	0.997	0.993	0.292	Yes
PSE	0.999	0.993	0.674	Yes
Composite (Step 3a)				
Construct	MD	95% CI	p	Equal means
ATT	0.312	[-0.186, 0.190]	0.002	No
PPB	-0.269	[-0.206, 0.199]	0.010	No
PPBf	0.262	[-0.202, 0.196]	0.008	No
PPR	-0.456	[-0.194, 0.205]	0.000	No
PSE	0.159	[-0.186, 0.198]	0.110	Yes

Construct means (Likert 1–5)



Significant differences

- 16–18 higher: ATT, PPBf
- 19–24 higher: PPR, PPB
- No significant difference: PSE

Table IV (excerpt)

TABLE IV. MEAN DIFFERENCES

Mean (SD)	Age Group		p
	16-18	19-24	
ATT	2.60 (0.69)	2.38 (0.77)	0.002
PPB	2.97 (0.75)	3.16 (0.78)	0.012
PPBf	3.09 (0.93)	2.84 (1.01)	0.012
PPR	3.44 (0.93)	3.85 (0.84)	< 0.001
PSE	3.04 (0.78)	2.92 (0.90)	0.153

Most paths are invariant across age

- PSE → PPB remains positive in both groups (core mechanism holds)
- PPR and PPBf show similar relationships to PSE/PPB across ages
- Only one developmentally sensitive pathway emerges

Significant difference

ATT → PSE is stronger for older youth

$\beta(19-24)=0.567$ vs. $\beta(16-18)=0.356$ • $p=0.024$

Interpretation: trust translates into capability more effectively with greater autonomy/maturity.

MGA results (Table VI)

TABLE VI. MULTIGROUP ANALYSIS

Structural Path	β Age Group 16-18	β Age Group 19-24	β Difference	p-value
ATT → PPB	0.042	0.125	0.083	0.485
PPBf → PPB	-0.163	-0.152	0.012	0.912
PPR → PPB	0.307	0.337	0.030	0.791
PSE → PPB	0.330	0.376	0.046	0.655
ATT → PSE	0.356	0.567	0.212	0.024
PPBf → PSE	0.162	0.012	-0.150	0.159
PPR → PSE	0.004	0.045	0.040	0.696

Younger youth (16–18): bridge the efficacy gap

- Guided privacy flows: contextual decisions, not dense menus
- Explain immediate consequences of data capture/retention
- Household-aware controls: delegated/shared review and nudges

Older youth (19–24): support autonomy + advanced control

- Transparency dashboards: data flows, retention, audit trails
- Reversible opt-out and actionable logging
- Fine-grained & temporal permissions (context-specific controls)

Cross-age constant: prioritize self-efficacy (PSE) as the lever for protective behavior (PPB).

Age tailoring mostly changes *how* trust/transparency becomes actionable—not whether efficacy matters.

Limitations

- Cross-sectional survey limits causal inference
- Self-reported privacy behaviors may differ from observed actions
- Device ownership / household governance not directly measured
- Canada-only sample; age split may obscure within-group variation

Next steps

- Longitudinal designs to track development of PSE and PPB over time
- Add direct measures of autonomy: account admin, ownership, permissions
- Behavioral outcomes: observed settings changes, task performance
- Cross-cultural replications under different privacy regimes

Three takeaways

- Age shifts baseline perceptions (risk, trust, benefits, behavior).
- Across ages, self-efficacy (PSE) remains the direct driver of protective behavior (PPB).
- Developmental sensitivity appears in ATT → PSE (trust → capability), stronger for 19–24.

Action for practice: build privacy self-efficacy with age-appropriate controls and transparency.

Questions?

Thank you!