The effectiveness of sound gestures in early literacy instruction for students with intellectual disability: A single case study

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The effectiveness of sound gestures in early literacy instruction for students with intellectual disability: A single case study

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GPC und PA in students with intellectual disability

- Grapheme-phoneme correspondence (GPC) and phonemic awareness (PA) as key drivers for learning to decode

  (Ziegler & Goswani, 2005)

  and for storing sight words in long-term memory

  (Ehri, 2005)

- GPC and PA as important predictors for reading development in students with intellectual disabilities

  (Dessemontet and de Chambrier, 2015; van Wingerden et al., 2017)

Developing GPC und PA: strength or weakness?

- Developing GPC as a strength?

  (Channell et al., 2013)

- Developing PA as a weakness?

  (Dessemontet et al., 2017)

- In both cases students with intellectual disabilities need effective instruction like *systematic and direct instruction*

  (Bracey et al., 1975; Flores et al., 2004; Nietupsky et al., 1979; Wright et al., 2022)

  and intensive practice like in using *educational games*

  (Brennan & Miller, 2000; Stančin et al., 2020; Tripiana-Barbosa & de Souza, 2015)

Sound gestures

- are hand movements that respresent phonemes oriented towards sound production, such as mouth position, tongue movement or place of articulation (Balfe, 2003; Cihon et al., 2008; Xi et al., 2020)
- although named “hand cues” (Waddy-Smith & Wilson, 2003, p. 14), “hand gesture cues” (Rusiewicz & Rivera, 2017), “hand gesture” (Xi et al., 2020, p. 3571), “cued speech” (Cornett, 1967, p. 3) or “Cued Articulation” (Passy, 2003, p. xiv)
- draw attention to the pronunciation of individual phonemes in the flow of speech (Kart, 2023)

Sound gestures research

- Recommendation for *Cued Articulation* on language and literacy learning are based on experiences from teachers and case studies (Hampton, 2003; Passy, 2003)
- *Visual phonics* enhance early literacy learning, e.g. gpc, in deaf or hard of hearing students and kindergarten children with reading difficulties (Cihon et al., 2008; Gartner et al., 2013; Trezek & Wang, 2017; Tucci et al., 2014)
- A systematic review by Kart (2022): *Visual Phonics* is an effective strategy for enhancing early literacy learning for students with hearing impairments and reading difficulties
- Sound gestures are used to teach students with intellectual disability at German special schools (Tebbe, 2024), but no research on this topic could be found

1. Introduction
2. **Research Question**
3. Methods
4. Results
5. Discussion

Research Question

Is direct instruction **with sound gestures** more effective than direct instruction **without sound gestures** in teaching phonemic awareness and grapheme-phoneme correspondence in students with intellectual disability?

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Setting and participants

- Eight students (N = 8), four classes and two special schools
-

Student	Age	IQ	Diagnoses	GISC-EL row scoure						
				picture ID	symbol ID	syllable segm.	first sound	gpc	recod.	word ID
Dirk	11;0	57	DS	0	0	0	0	0	0	0
Lara	12;5	57	DS	6	0	8	0	0	0	0
Nils	9;5	89	HKD	10	9	7	0	7	0	0
Ida	14;1	60	ADHD	6	6	0	0	10	0	0
Leo	13;4	61	Epilepsie	10	7	7	1	10	0	0
Jan	9;5			10	4	5	5	17	0	0
Eva	7;7			7	6	2	1	10	0	0
Kira	7;3	55	DWS	9	2	3	0	2	0	0

Intervention

- Small group instruction with 2-3 students - two times a week for 30 minutes
- Working on graphemes and phonemes already exposed in class
  but not yet learned
- Direct and systematic instruction with modelling and prompting strategies
  and educational games for intensive practise
- One task-set is thaught with the use of sound gestures.
  One task-set is thaught without the use of sound gestures.

Trainers and trainers instruction

- Two undergraduate students in the field of special education needs both had experiences in teaching students with intellectual disability
- Individually instructed in two 90 minutes sessions
- Regular contact and feedback with the research team

Measures

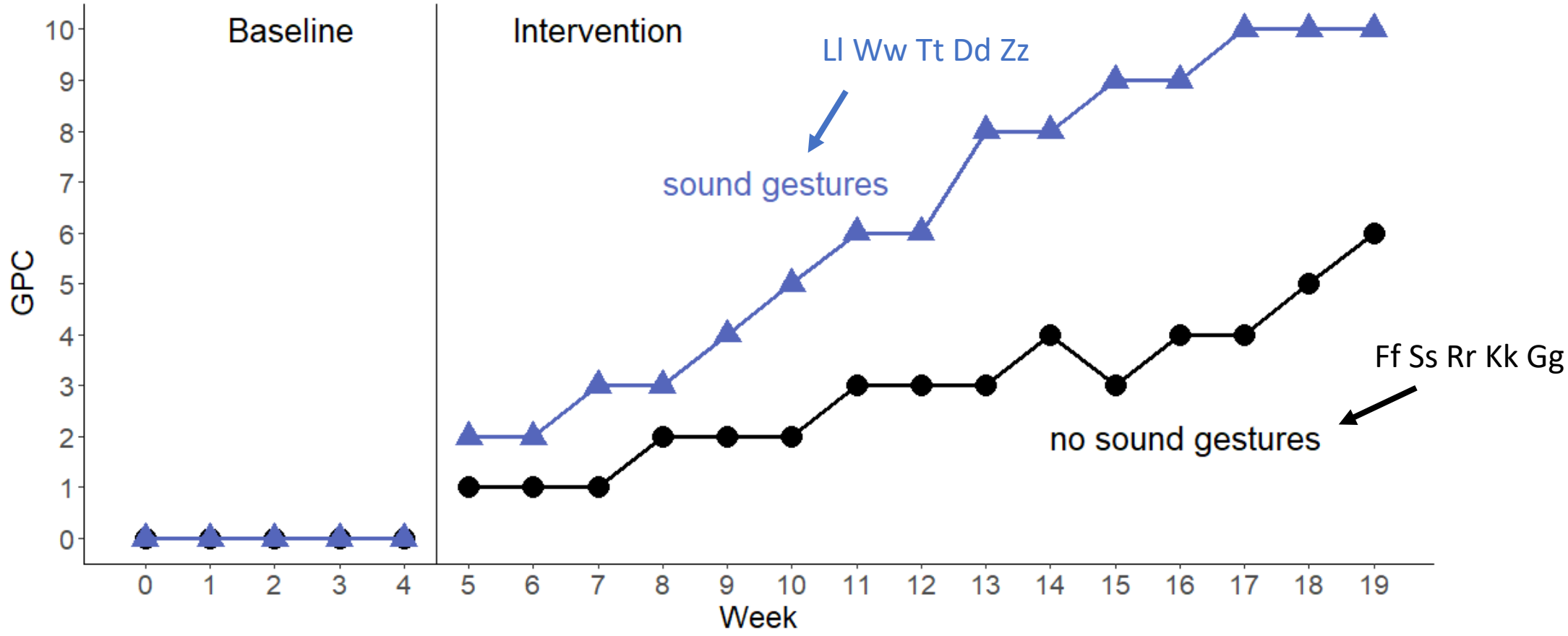
- Weekly measurements of GPC and PA by trainers
- GPC: ten lowercase and uppercase letters presented per display and read aloud, answer registration in response document (max. 20)
- PA: ten phonemes presented twice via well-known symbols per display to name the onset phonemes, answer registration in response document (max. 20)
- Interobserver-Reliability in PA: 98%/ 94% of 21%/ 21% (A-Phase/ B-Phase)
  Interobserver-Reliability in GPC: 98%/ 96% of 21%/ 21% (A-Phase/ B-Phase)
- Equivalence of task sets (Dummer-Smoch & Hackethal, 2016; Reuter-Liehr, 2020)

Single Case Experimental Design

Adapted Alternating Treatments Design, AATD (Sindelar et al., 1985)

- Rapid iterative alternation of conditions
- Non-reversible outcomes
- A different task set is applied to each condition

Adapted Alternating Treatments Design



Threats to internal validity (Shepley et al., 2020)

Threat	Controlled
Inequivalence of task sets	partially
Sequence effects	no
Carryover effects	no
Participants‘ history with interventions	partially

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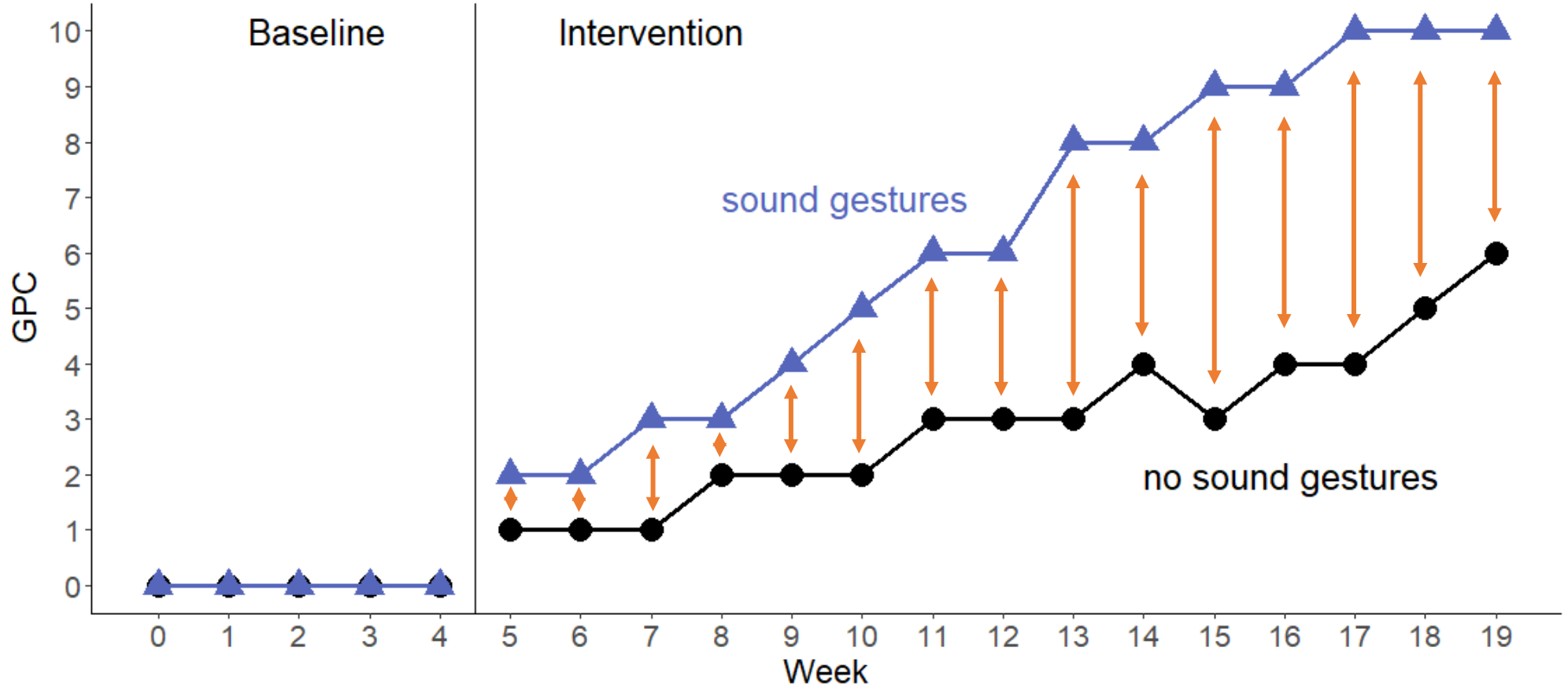
Descriptive Results

	PA & GPC			PA		GPC	
	n_A (NA)	n_B (NA)	$n_{foll.}$ (NA)	$M_{Agest.}$ (*SD*)	M_A (*SD*)	$M_{Agest.}$ (*SD*)	M_A (*SD*)
Dirk	8 (1)	19 (3)	2 (0)	0 (0)	0 (0)	0.1 (0.4)	0 (0)
Nils	8 (0)	21 (1)	2 (0)	0 (0)	0 (0)	1 (1.1)	1.4 (0.7)
Lara	8 (2)	18 (4)	2 (1)	0.3 (0.8)	0.3 (0.8)	1.2 (0.8)	0.3 (0.5)
Ida	8 (0)	19 (0)	2 (0)	0.1 (0.4)	0.3 (0.7)	0.1 (0.4)	0.5 (0.9)
Leo	8 (0)	18 (1)	2 (0)	0.3 (0.5)	0.4 (0.7)	0.5 (0.5)	1 (0.8)
Jan	5 (0)	15 (1)	2 (0)	2.8 (0.8)	2.8 (1.3)	2.2 (0.4)	3.5 (0.5)
Eva	5 (0)	15 (1)	2 (0)	0.2 (0.4)	0.4 (0.5)	0.4 (0.5)	0.8 (0.8)
Kira	7 (0)	14 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Data Analysis: Expectation



Visual Analysis (Ledford et al., 2024)

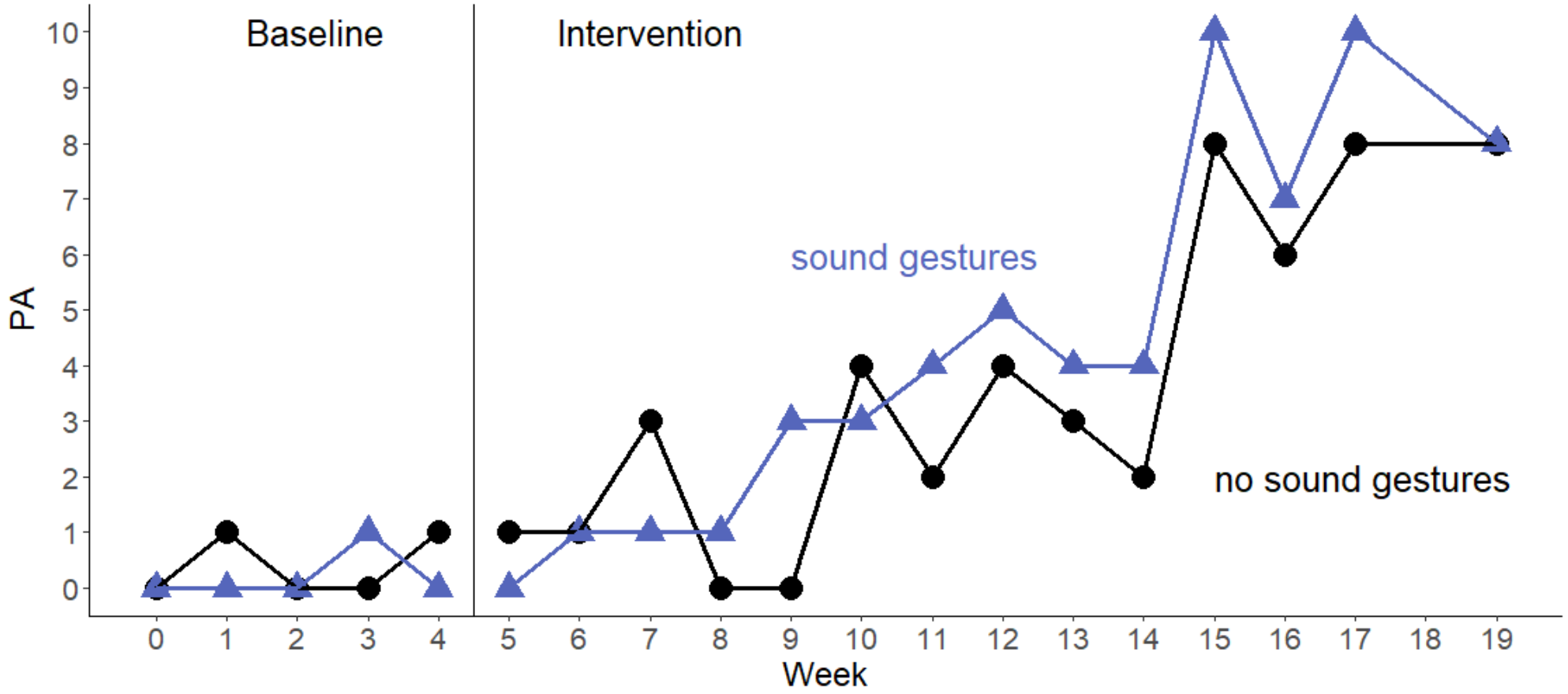
Data pattern from both conditions show no clear separation.

There is substantial overlap between the conditions.

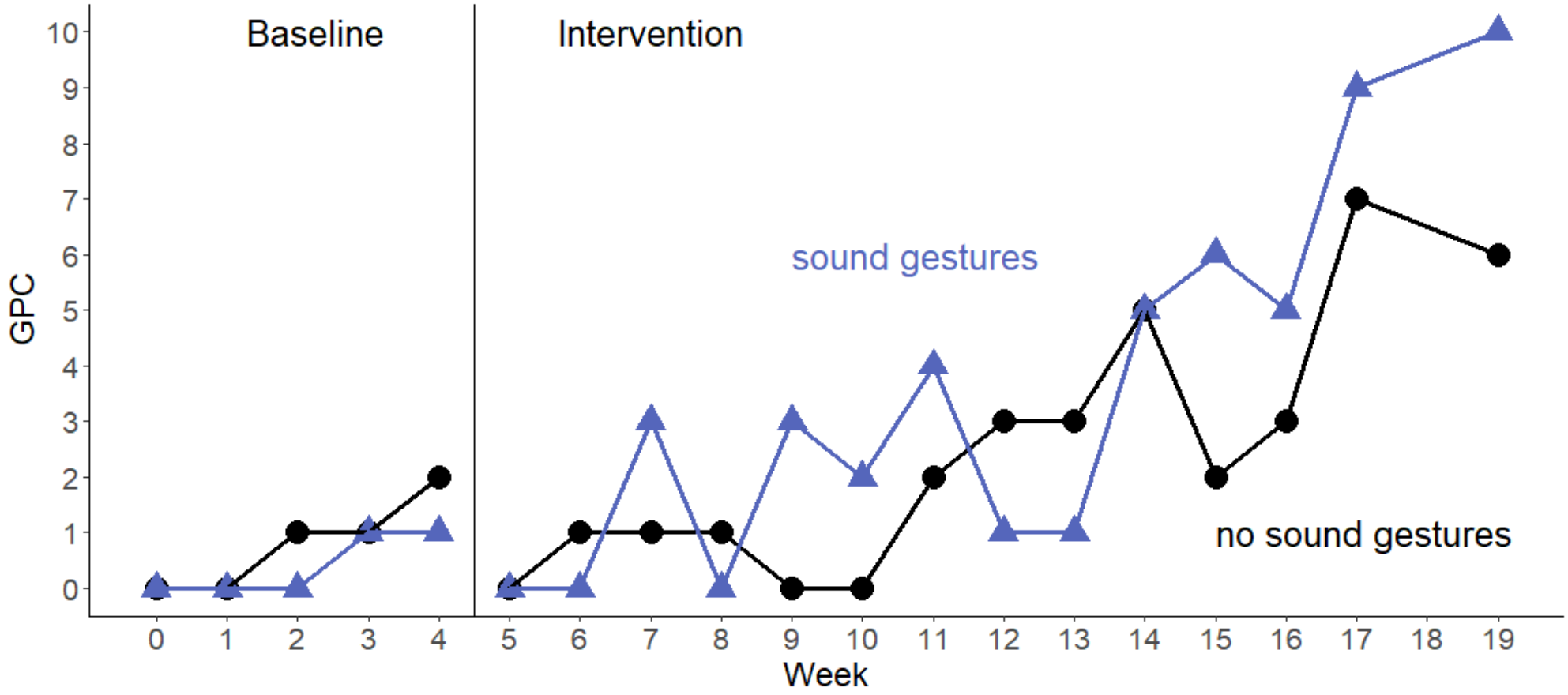
No difference in slope: The sound gestures condition did not result in faster acquisition than the no sound gestures condition.

Conclusion: no functional relation

Example PA: Eva



Example GPC: Eva



Effect Size Calculation (Manolov & Onghena, 2018)

ADISO-O: percentage of comparisons in which the sound gestures condition is superior to the no sound gestures condition

$$ADISO - Oj = \frac{\sum_{i=1}^{n}(y_{sound\ gestures} > y_{no\ sound\ gestures})_{ij}}{n_j}$$

ADISO: Mean difference

$$ADISO_j = \frac{\sum_{i=1}^{n}(y_{sound\ gestures} - y_{no\ sound\ gestures})_{ij}}{n_j}$$

$Slope_{diff}$: OLS-Trend of the differences

$$(y_{sound\ gestures} - y_{no\ sound\ gestures})_{ij} = b_{0j} + b_1 Time_{ij} + e_{ij}$$

Results: PA

	ADISO-O	ADISO	$Slope_{diff}$	$ADISO_{follow\text{-}up}$	Weight
Dirk	69%	1.25	0.16	6.5	12.5 %
Nils	60%	0.90	0.03	0.5	15.6%
Lara	50%	0.79	0	0	10.9%
Ida	53%	0.74	0	3	14.8%
Leo	41%	0.53	0	0.5	13.3%
Jan	36%	0.50	-0.09	0.5	10.9%
Eva	64%	0.79	0.14	0	10.9%
Kira	79%	1.43	0	-1	10.9%
Summary Effect	56%	0.86	0.03	1.35	100%

Note. The summary effect is a weighted mean with weights corresponding to the number of measurement occasions in the intervention phase.

Results: GPC

	ADISO-O	ADISO	$Slope_{diff}$	$ADISO_{follow\text{-}up}$	Weight
Dirk	50%	0.84	-0.05	4	12.5 %
Nils	80%	1.75	0.18	2.5	15.6%
Lara	36%	-0.07	0.10	-1	10.9%
Ida	84%	1.26	0.06	2.5	14.8%
Leo	88%	1.56	0	0.5	13.3%
Jan	64%	0.46	0.08	0	10.9%
Eva	57%	1.07	0.20	0	10.9%
Kira	57%	1.21	-0.35	-0.5	10.9%
Summary Effect	66%	1.06	0.03	1.16	100%

Note. The summary effect is a weighted mean with weights corresponding to the number of measurement occasions in the intervention phase.

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Summary

We investigated if direct instruction with sound gestures is more effective than direct instruction without sound gestures in teaching PA and GPC to 8 students with intellectual disability.

The additional use of sound gestures did not lead to faster acquisition of PA and GPC in all students, or only to a very minor extent.

Discussion

Sound gestures may constitute an additional cognitive load that hinders learning, especially for students with intellectual disability who exhibit lower working memory capacity.

The sound gestures may distract from the actual task. The students might focus more on producing the gestures than on analyzing the phonemes or graphemes.

Hence, the potential benefits of sound gestures in supporting students in phoneme discrimination cannot be fully leveraged.

Limitations

Implementation fidelity not assessed (Gadge et al., 2018)

Trainers preparation for the program not assessed (Barton et al., 2018)

More careful consideration is required to ensure task equivalence

Sequence effects and carryover effects not controlled

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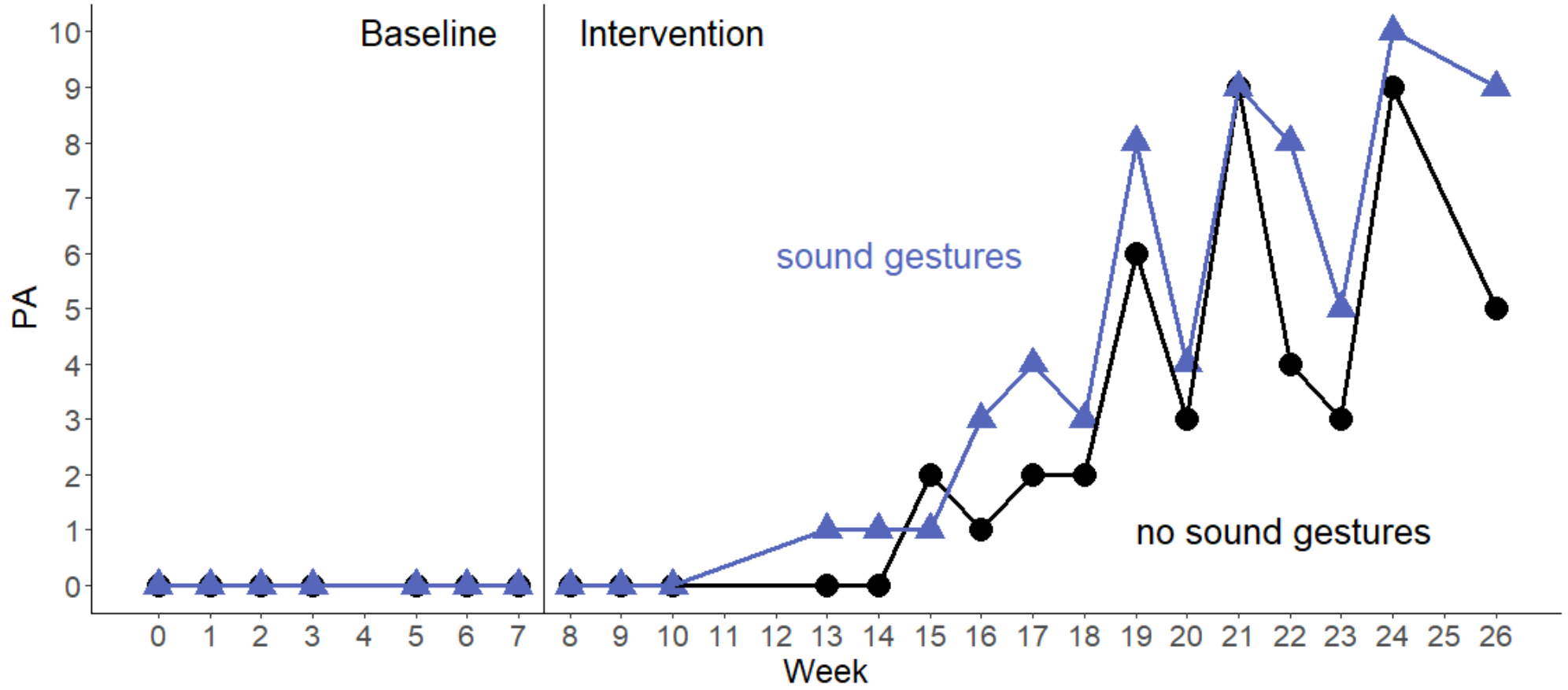
Dirk: PA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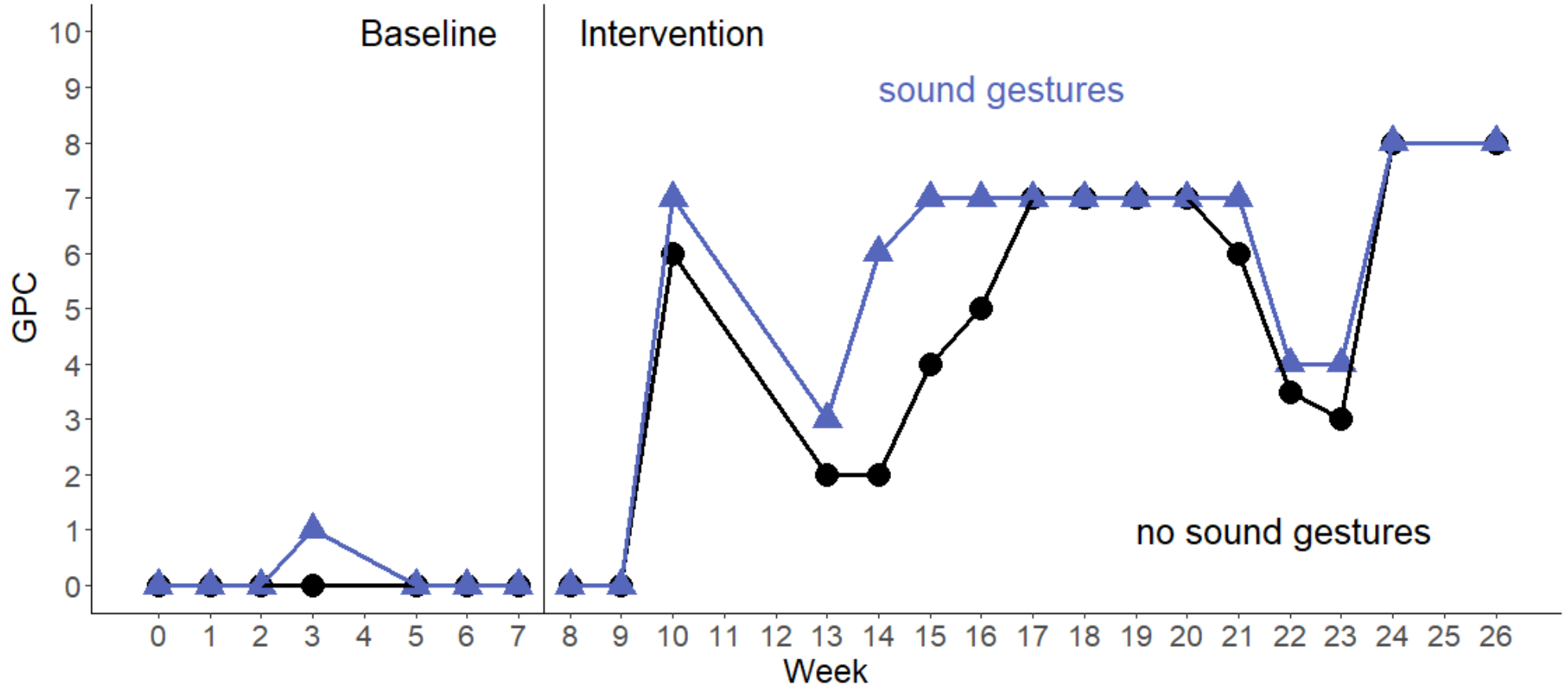
Dirk: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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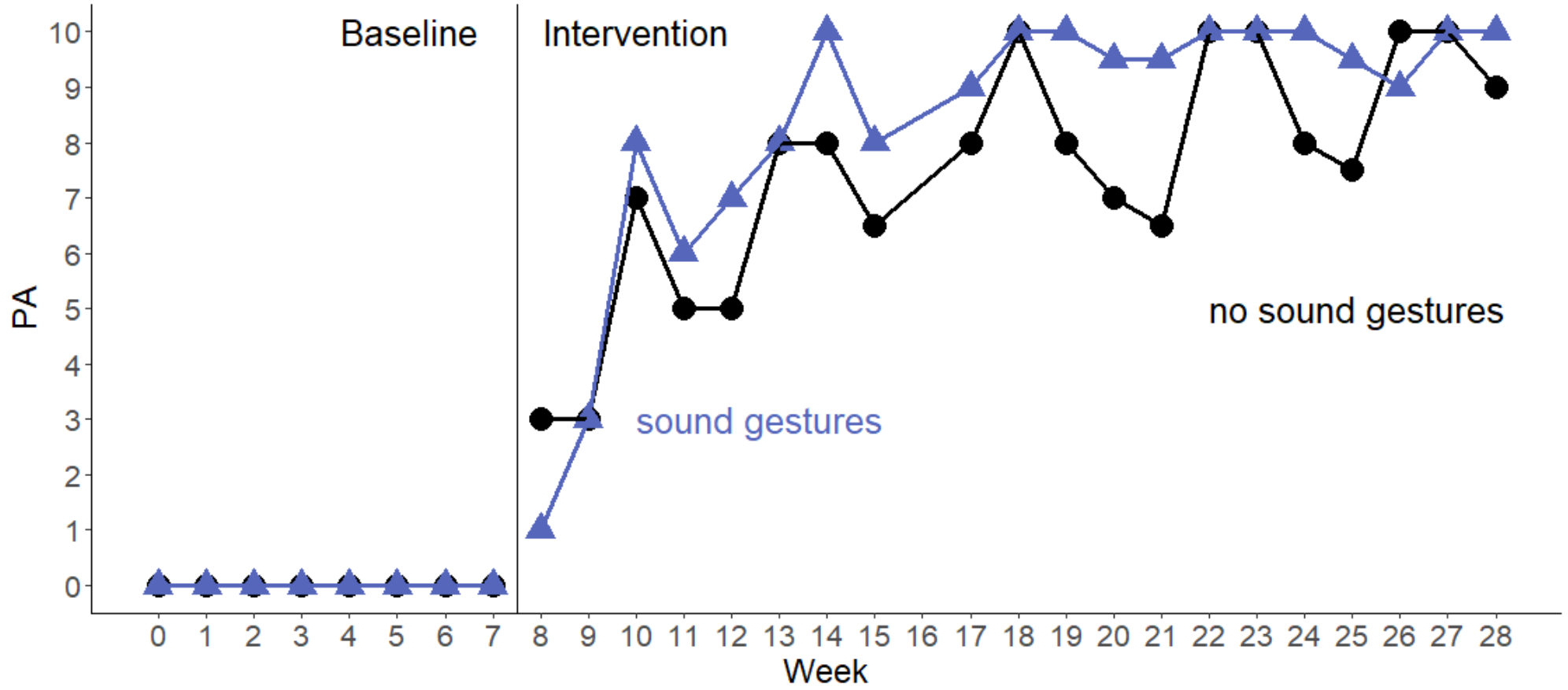
Nils: PA


Baseline
Intervention
PA
Week
sound gestures
no sound gestures
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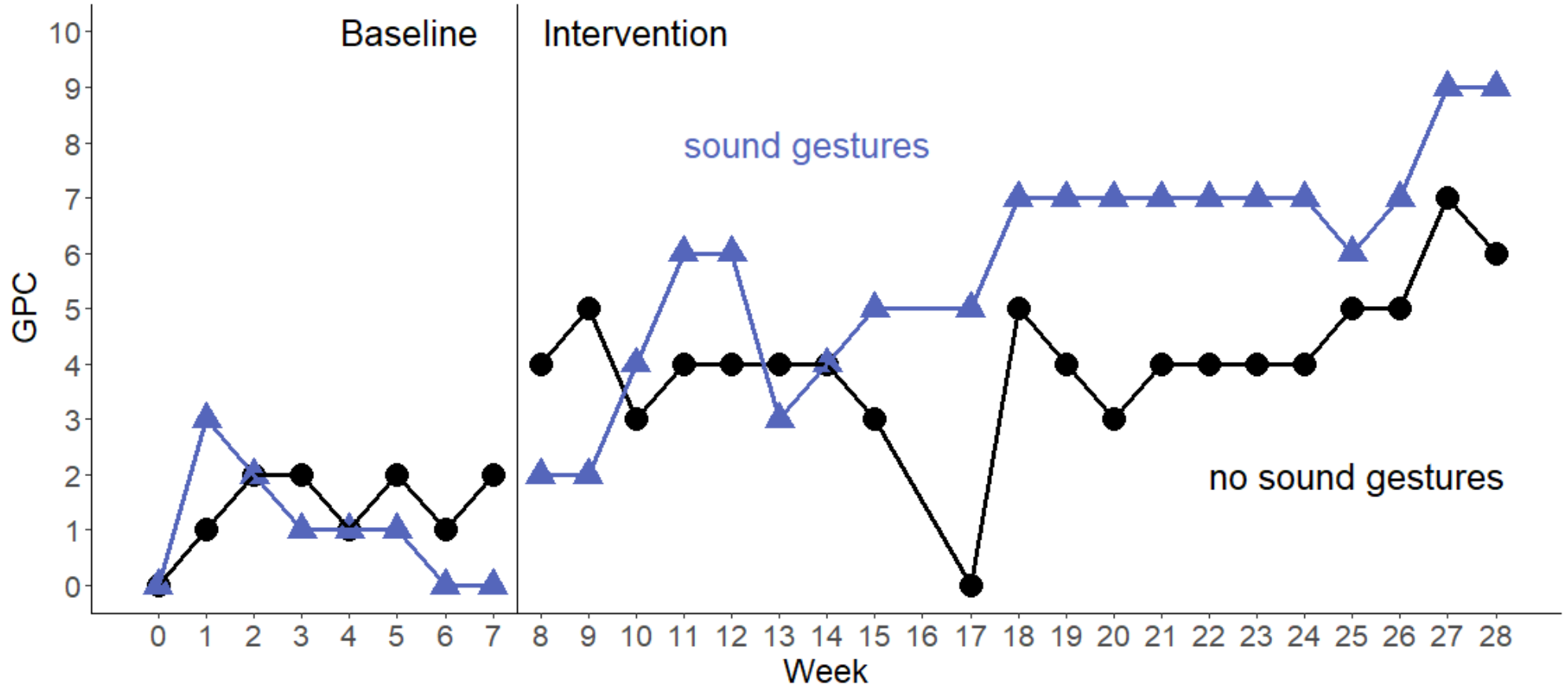
Nils: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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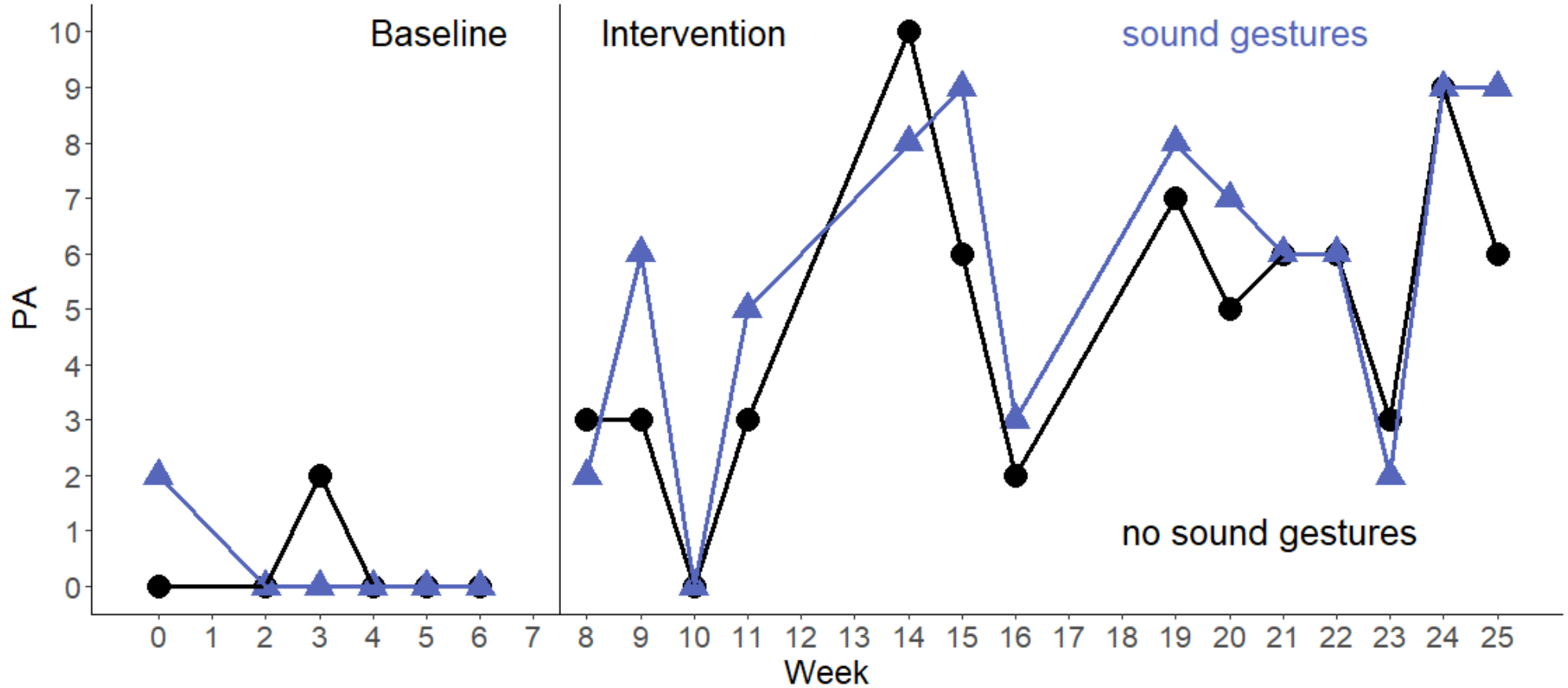
Lara: PA


Baseline
Intervention
sound gestures
no sound gestures
PA
Week
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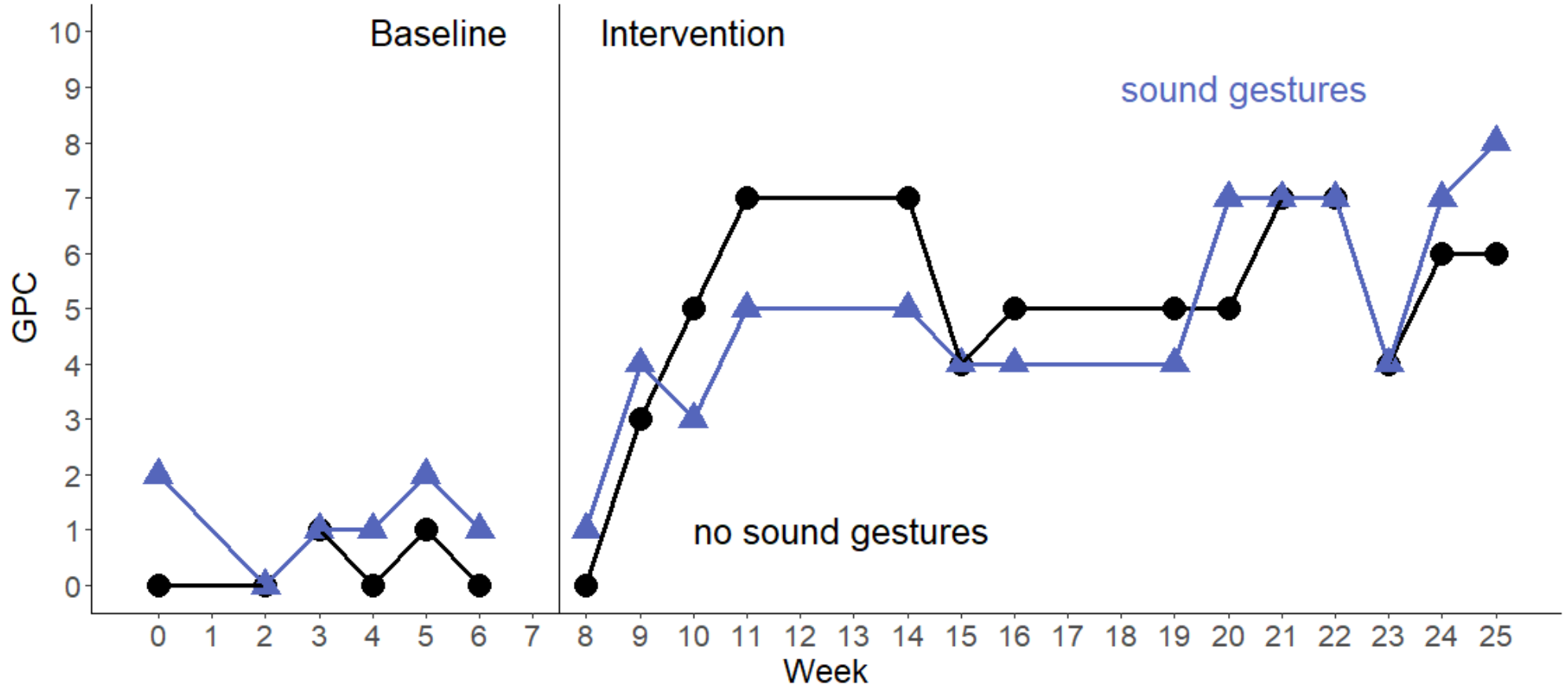
Lara: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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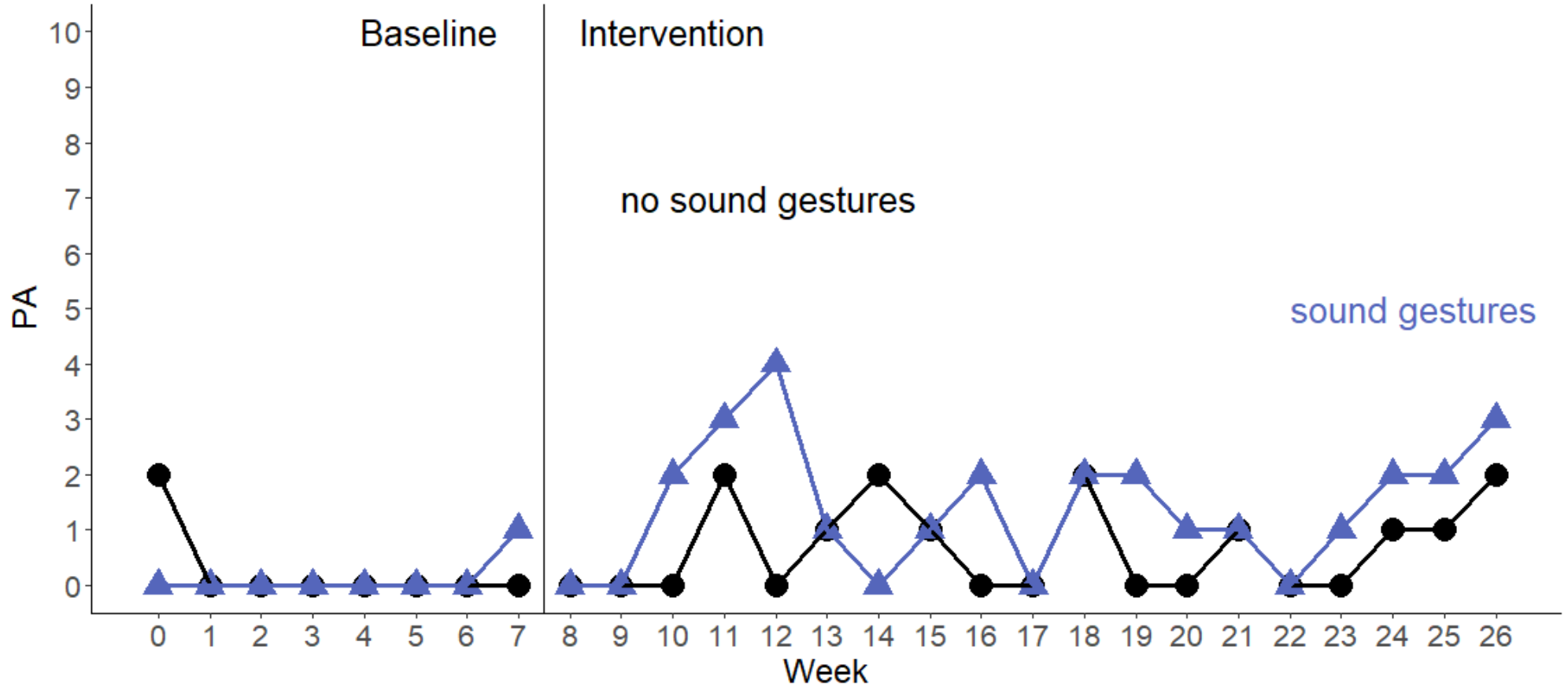
Ida: PA


Baseline
Intervention
no sound gestures
sound gestures
PA
Week
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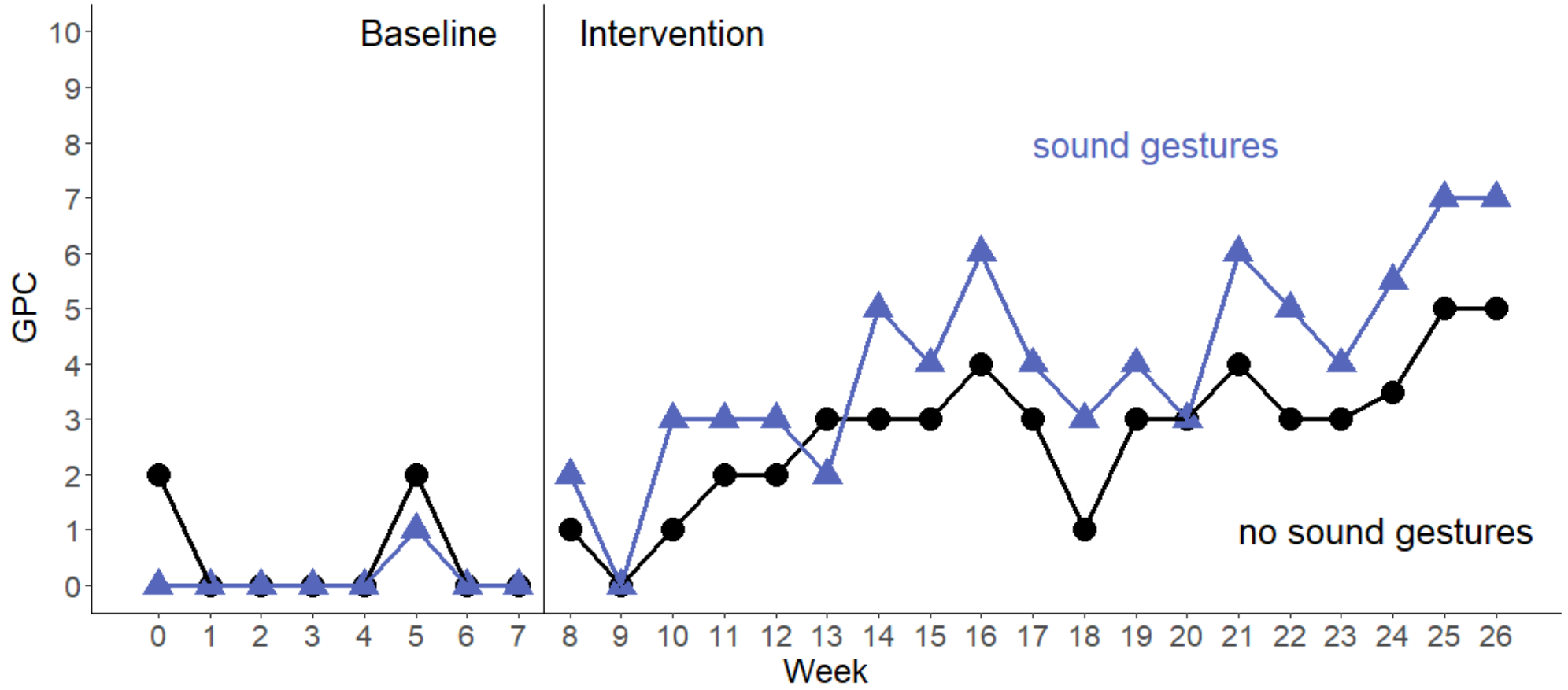
Ida: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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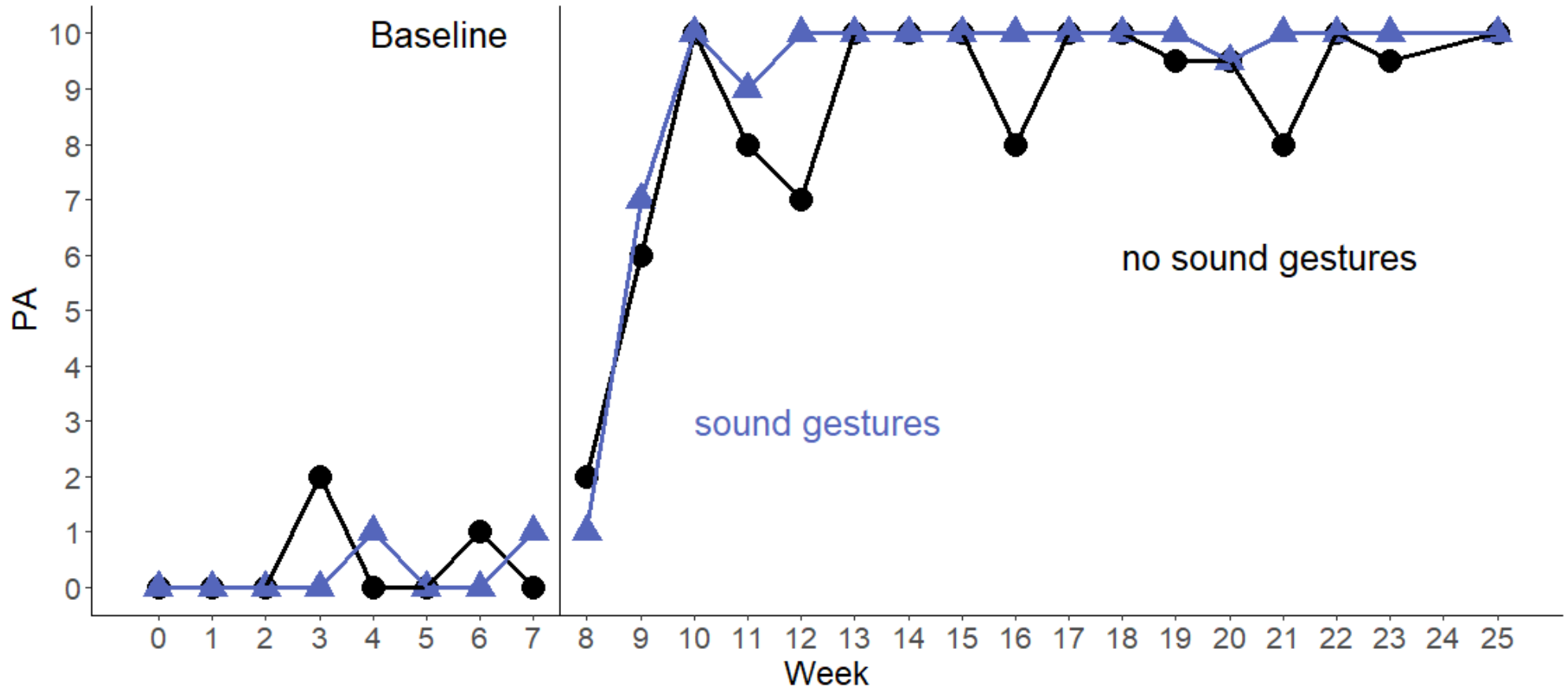
Leo: PA


Baseline
no sound gestures
sound gestures
PA
Week
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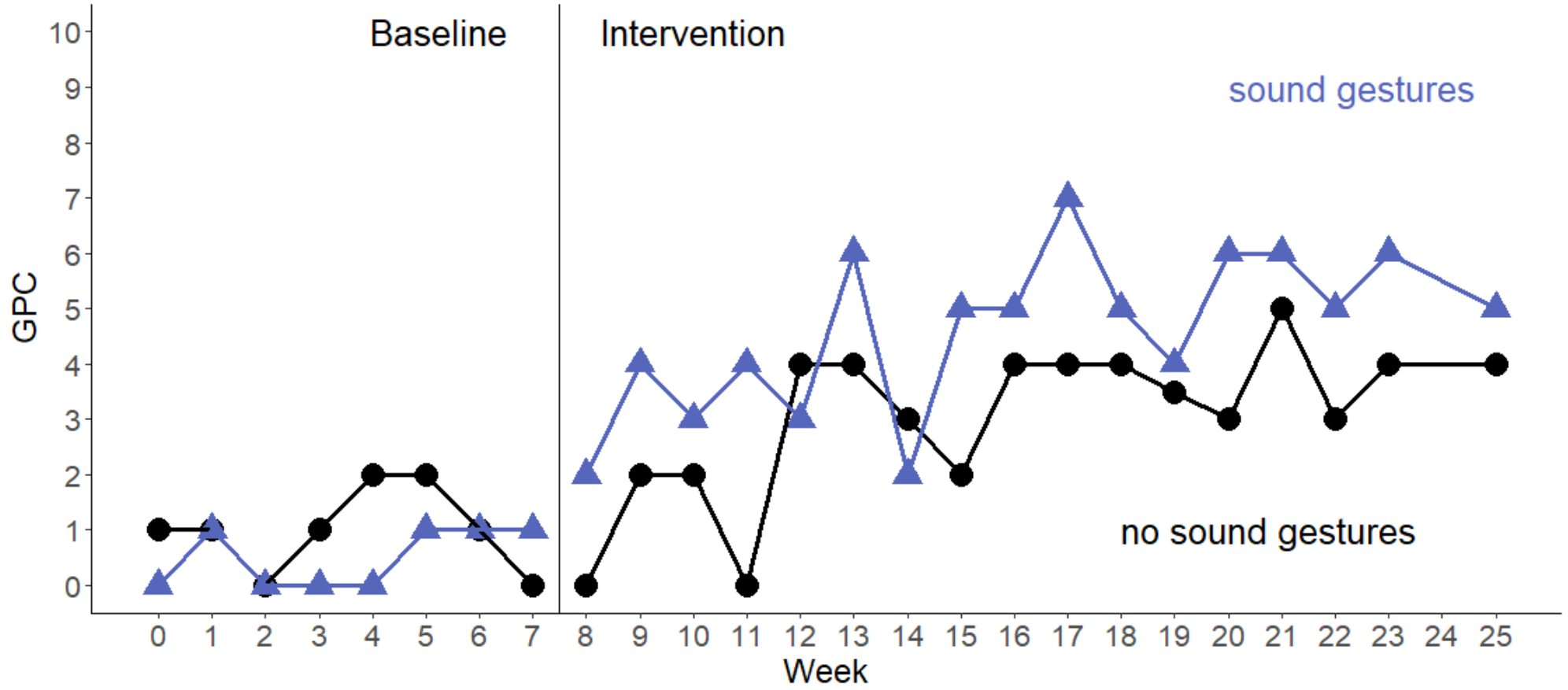
Leo: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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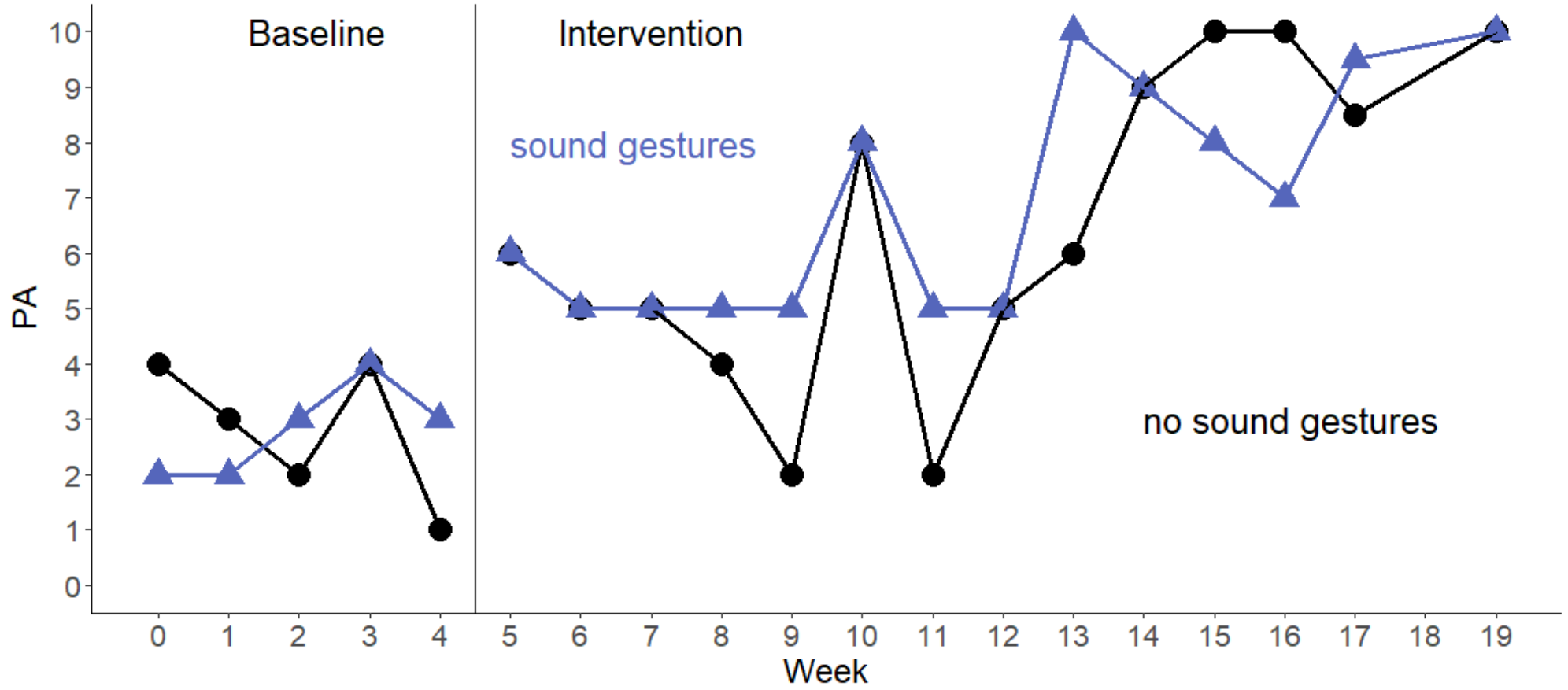
Jan: PA


Baseline
Intervention
sound gestures
no sound gestures
PA
Week
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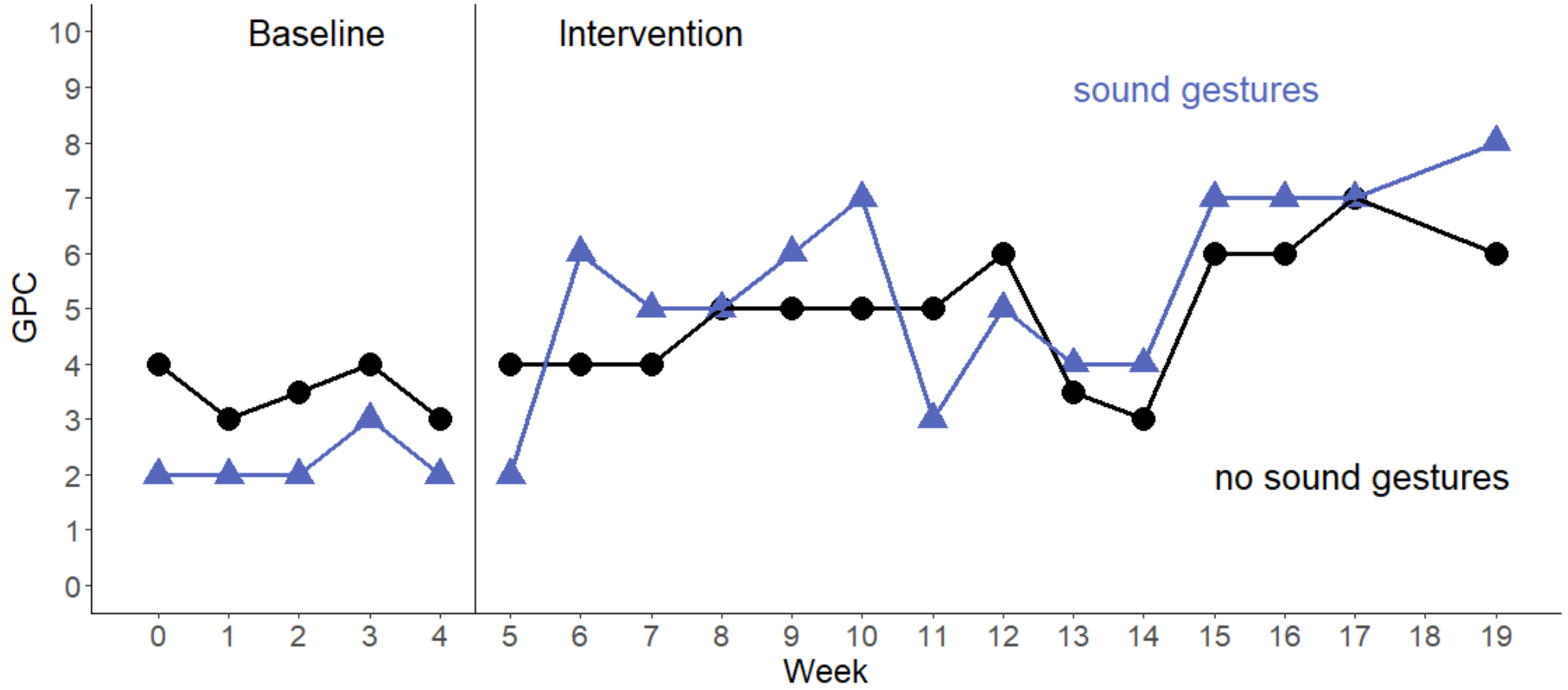
Jan: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
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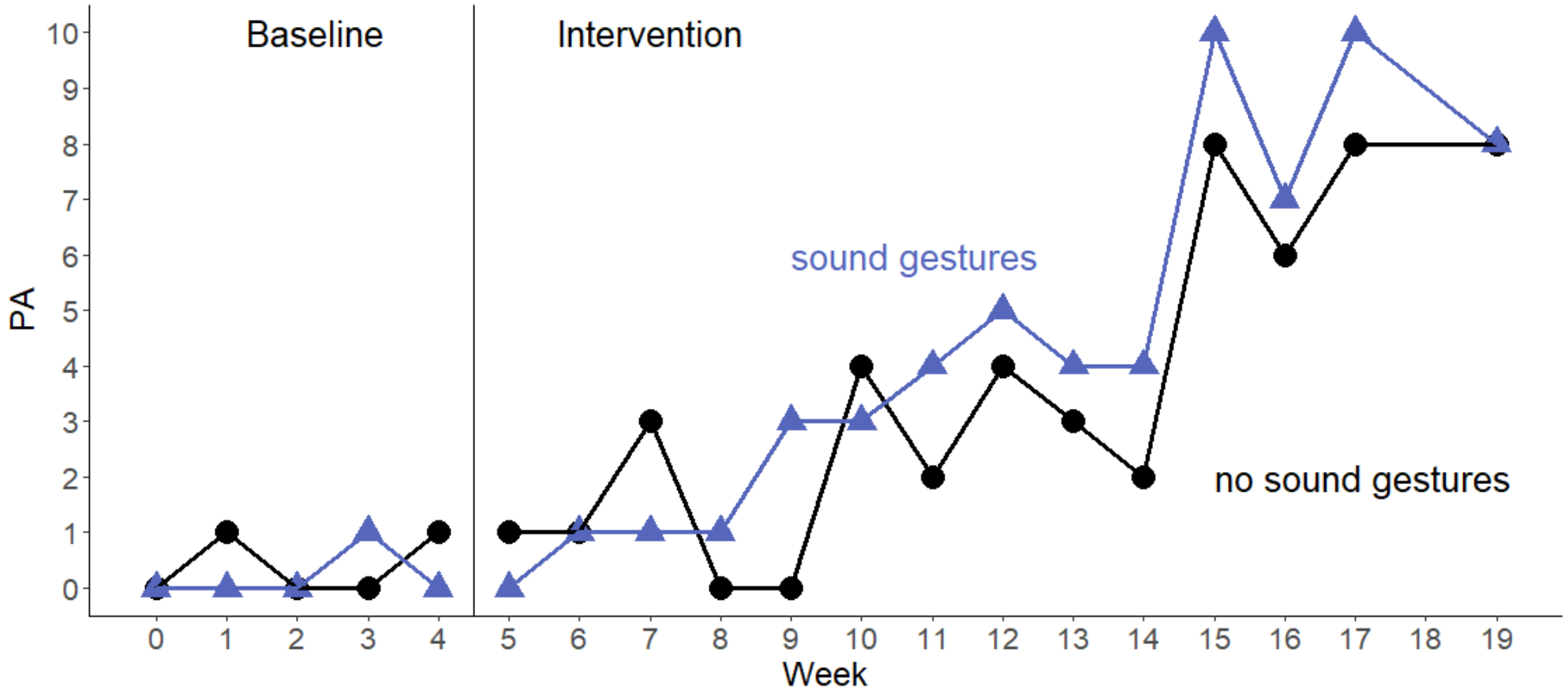
Eva: PA


Baseline
Intervention
sound gestures
no sound gestures
PA
Week
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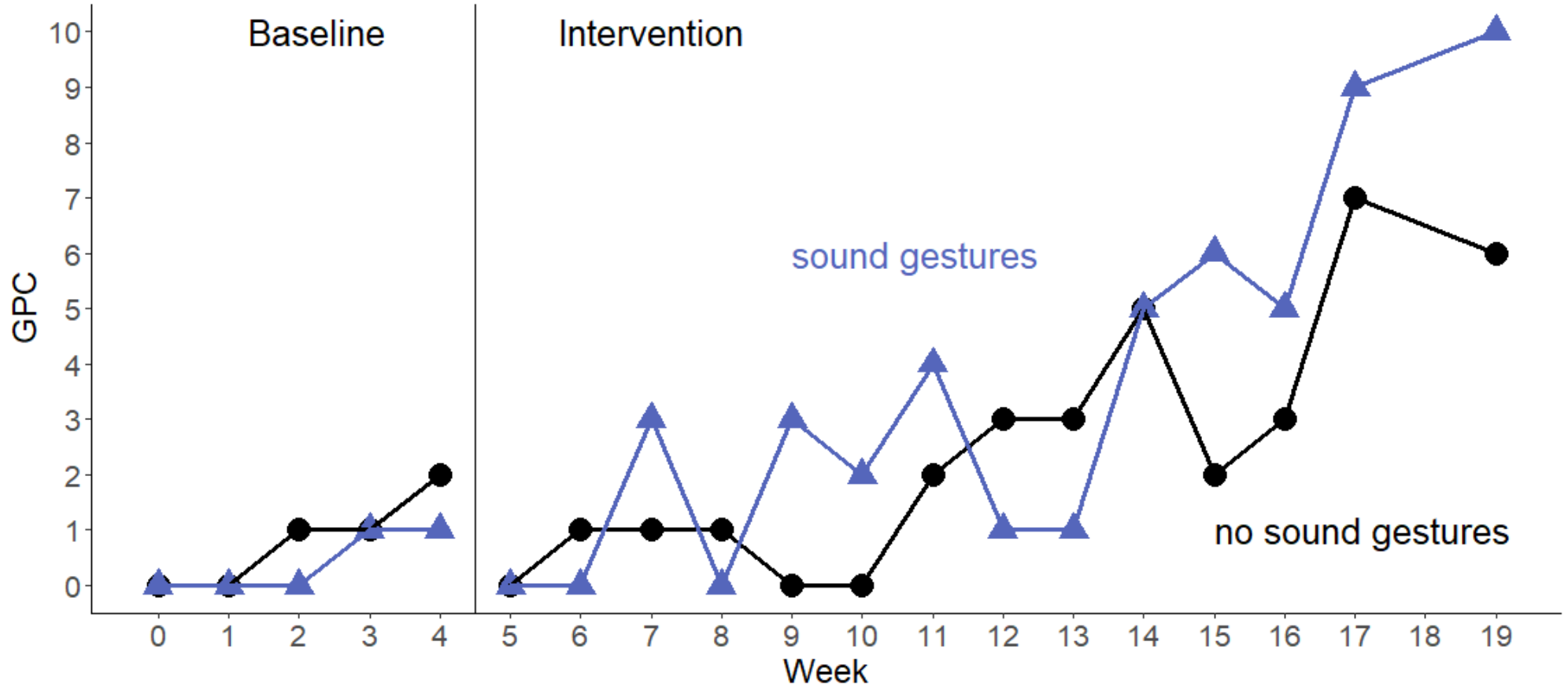
Eva: GPC


Baseline
Intervention
sound gestures
no sound gestures
GPC
Week
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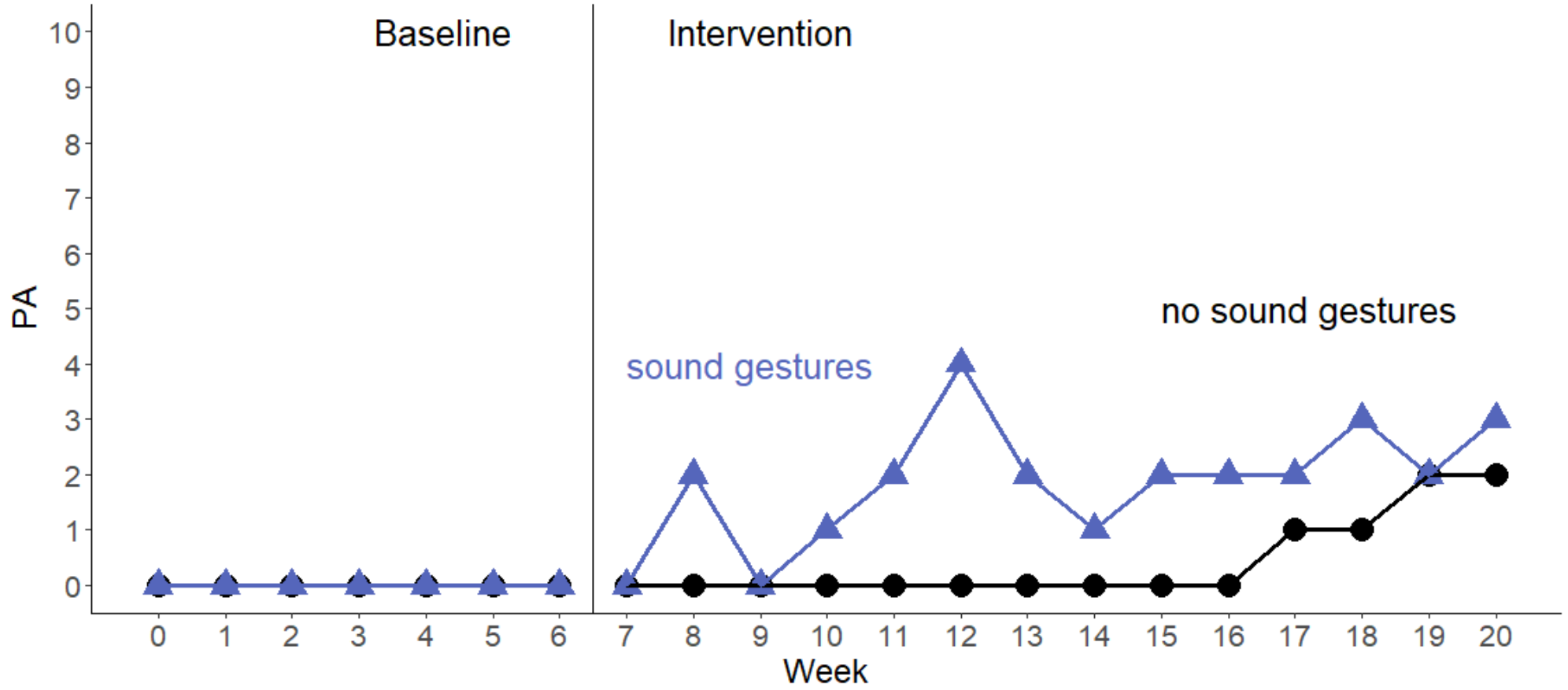
Kira: PA


Baseline
Intervention
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sound gestures
no sound gestures
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Week

Kira: GPC