

# Negation Processing in Polish, Ukrainian, and Russian: Evidence from Eye-movements in Blank Screen Visual World Paradigm

Dorota Klimek-Jankowska, Piotr Gulowski, Hanna Kędzierska (University of Wrocław)

Clara McMahon, Valeriia Modina, Irina Sekerina (CUNY)

Contact: dorota.klimek-jankowska@uwr.edu.pl



## The puzzle

How do comprehenders process negative statements? Imagine the following:  
**THE MONKEY DID NOT BREAK A COCONUT.**

## Two models of processing negation

**TWO-STEP MODEL** — While processing a sentence like *The monkey didn't break a coconut*, the listener first imagines a broken coconut before forming the negative meaning involving a whole coconut (Dale and Duran, 2011, Dudschig and Kaup, 2018, Tian and Breheny, 2016 a.o.).

**ONE-STEP MODEL** — the negative meaning involving a whole coconut is obtained directly (Du et al., 2014, Orenes et al., 2014, Tian et al., 2010 a.o.).



## Goal

- To examine how negation is processed in Polish, Ukrainian and Russian using a Visual World Experiment with a Blank Screen Paradigm by extending the VWP study by (Vanek et al., 2024).
- They tested negation processing in Croatian (a negative concord) and English (a non-negative concord). Their results suggest a direct rather than a two-step model of negation processing in both languages.

## Background and predictions

- In **POLISH, UKRAINIAN** and **RUSSIAN** aspect is morphologically marked on verbs. PFV verbs describe completed and IPFV verbs refer to unbounded events, (Borik, 2006).
  - However, East Slavic and West Slavic differ in how negation interacts with PFV and past tense (Dickey and Kresin, 2009, Kagan, 2020).
  - To express the meaning that *John did not steal a vase* at any point in time, Pol uses PFV and Rus and Ukr IPFV.
    - a. Ja ne KRAV starovynnu vazu. **UKRAINIAN**  
I not steal.**IPFV** ancient vase
    - b. Ja ne KRAL starinnuju vazu. **RUSSIAN**  
I not steal.**IPFV** ancient vase
    - c. Nie UKRADLEM starozytniej wazy. **POLISH**  
not steal.**PFV**.1SG ancient vase  
'I did not steal an ancient vase.'
  - Ja ne vkrav starovynnu vazu. **UKRAINIAN**  
I not steal.**PFV** ancient vase
  - Ja ne ukral starinnuju vazu. **RUSSIAN**  
I not steal.**PFV** ancient vase  
'I did not steal an ancient vase.'
- PFV in Ukr and Rus gives rise to the inhibited event reading (Fábregas and González Rodríguez, 2020) implying that John either planned or attempted the event but failed to realize it.



**PREDICTION** Ukr and Rus NEG + PFV past tense sentences are processed as predicted by the two-stage model and Pol neg + pfv past tense sentences are processed in line with the one-stage model. We test this hypothesis in a VWP pilot experiment implementing the Blank Screen Paradigm in Pol and Ukr.

## The Experiment

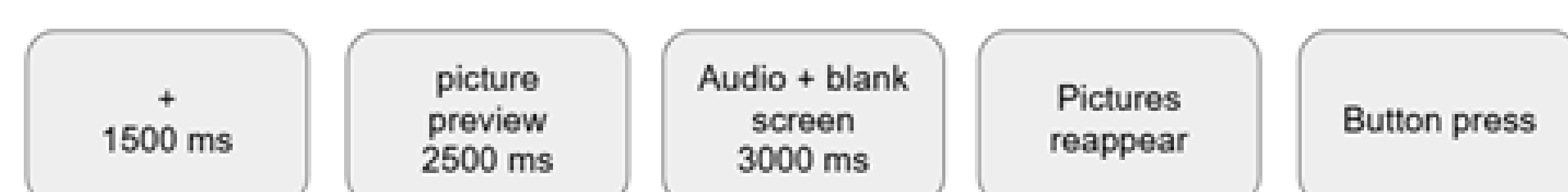


Figure 1: Structure of a trial

This structure allowed us to differentiate between anticipatory (when pictures disappeared) and integratory processing (after the images reappeared).

## Visual and audio stimuli

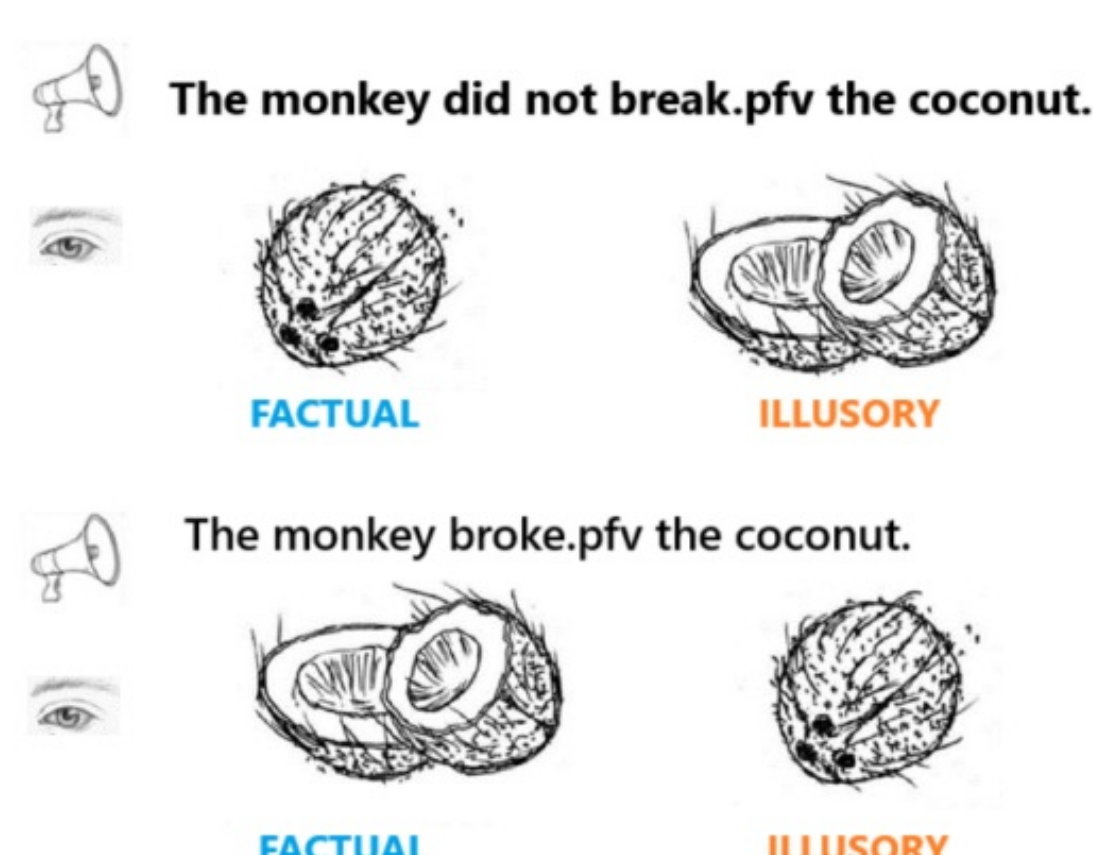


Figure 2: Visual and audio stimuli. Source: Vanek et al., 2024

## Participants and materials

**Participants:** 40 native Polish speakers (9 men;  $M_{age} = 22.23$ ,  $SD = 2.77$ , range = 19–30 years), 39 native Ukrainian speakers (9 men;  $M_{age} = 27.62$ ,  $SD = 10.89$ , range = 18–54 years), and 40 native Russian speakers (11 men, 28 women, and 1 non-binary person;  $M_{age} = 32.83$ ,  $SD = 9.55$ , range = 20–55 years).

**Materials:** 20 affirmative and 20 negative sentence pairs plus 20 fillers coupled with black and white picture pairs. Both pictures and audio stimuli were the same as in Vanek et al., 2024 translated to Polish, Ukrainian, and Russian. The trial order was pseudo-randomized across participants. The positioning of the factual and illusory images was counterbalanced.

## Results

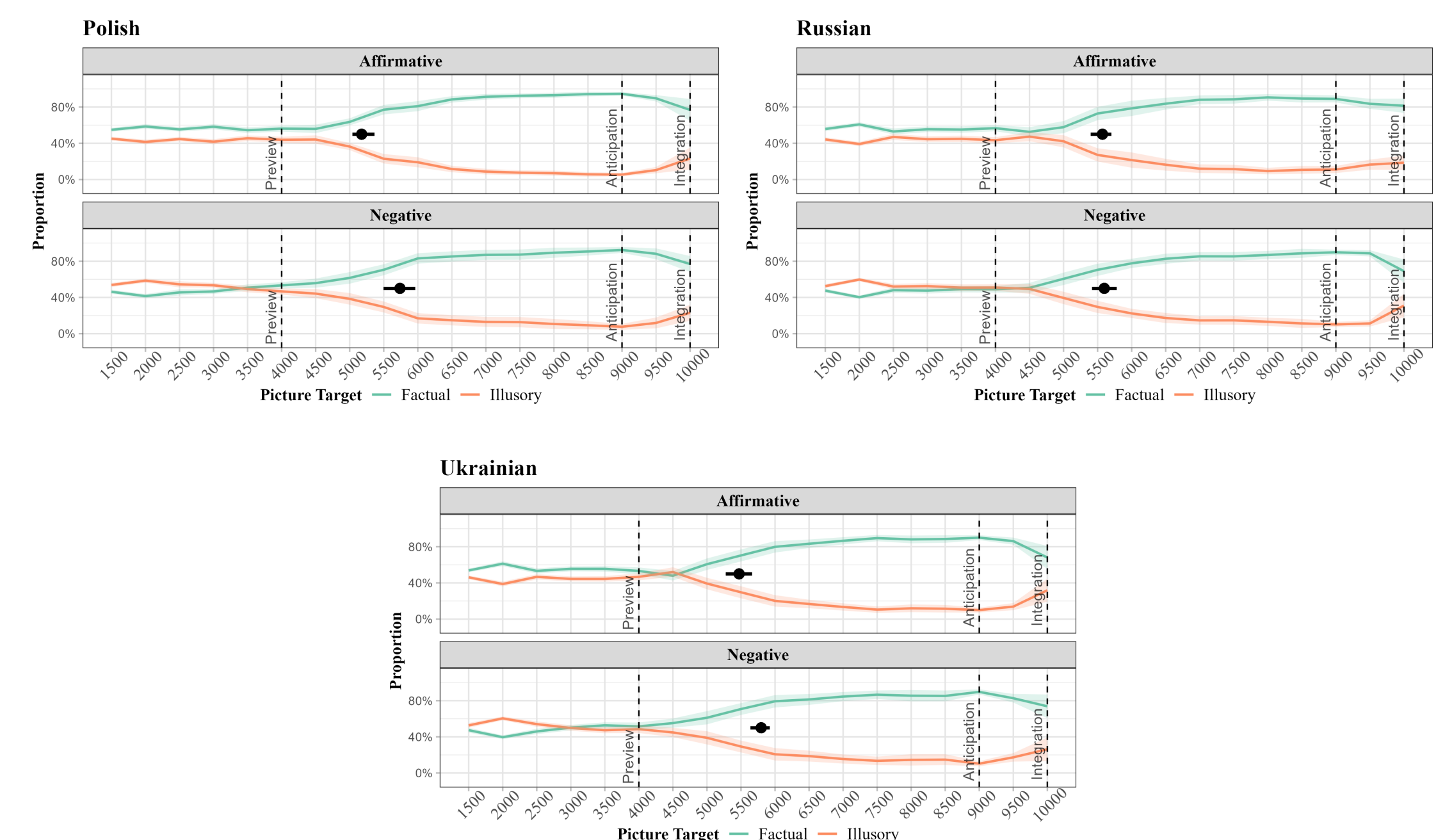


Figure 3: Proportions of looks to factual (green)/ illusory (red lines) with estimated divergence points (dots)

**Predictors:** *Language* (Polish, Russian, Ukrainian); *Sentence Type* (affirmative, negative)

**Tests:** *Binomial logistic regression models* fitted on proportion of looks to factual separately for Anticipation and Integration windows (Theobald et al., 2019); *Divergence-point analysis (bootstrapped)* of looks to factual vs. illusory between conditions (Stone et al., 2020).

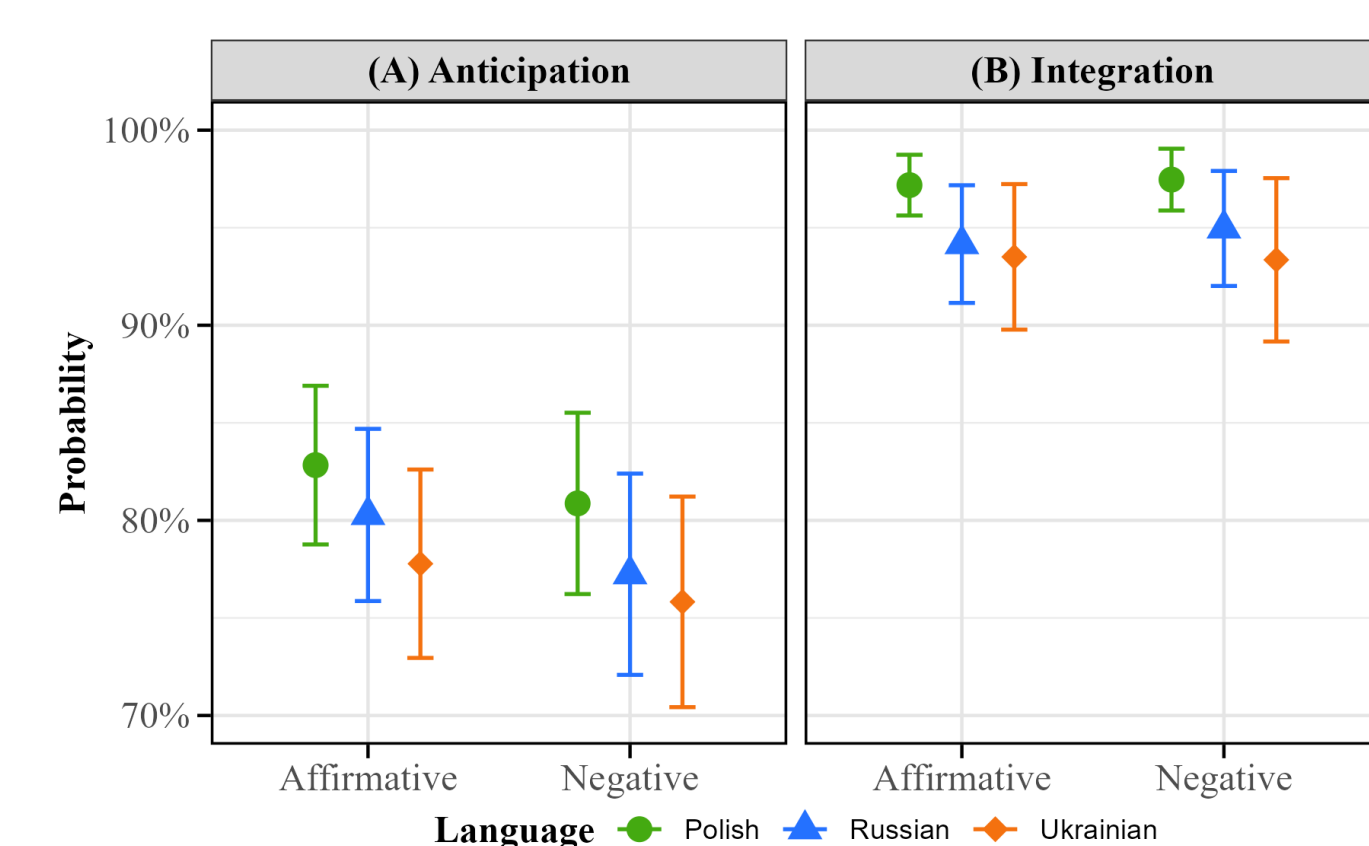


Figure 4: Model probabilities of looks to factual

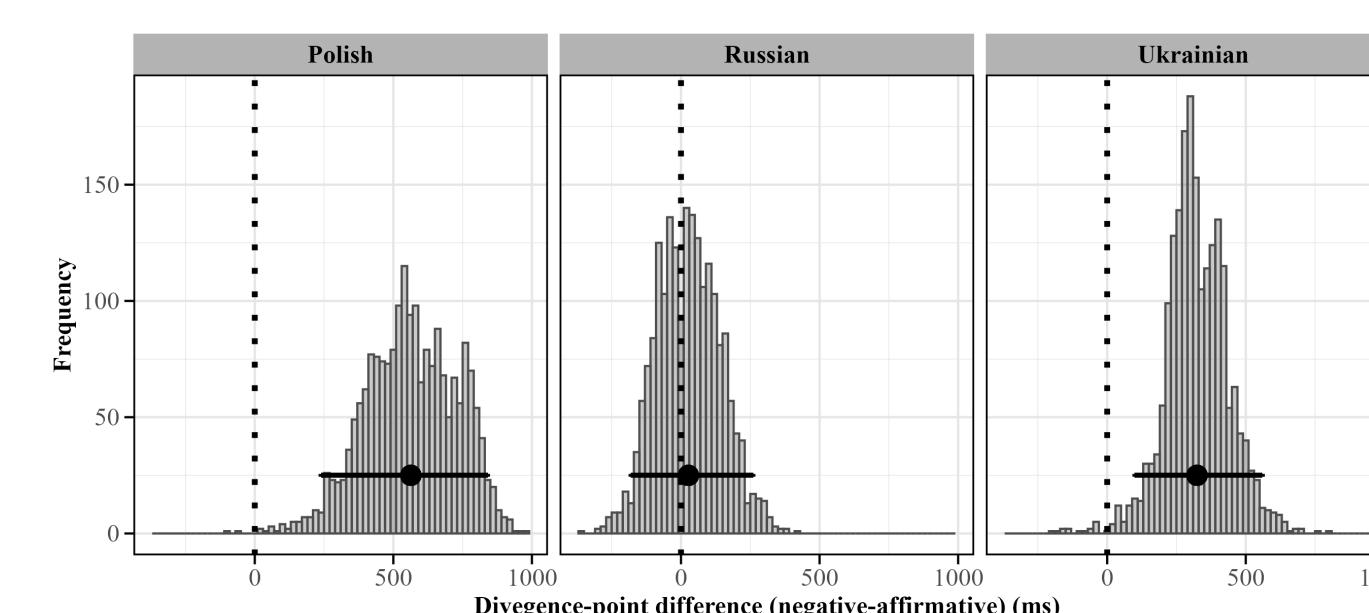


Figure 5: Estimated factual vs. illusory divergence point differences between affirmative and negative

**Anticipation window** - Significant Intercept ( $\beta=1.339$ ,  $SE=0.080$ ,  $z=16.729$ ,  $p<.001$ ) indicated a generally higher likelihood of fixating on the factual than illusory picture. The model predicted high probabilities of fixating on factual (>75%) for all conditions. The effect of Sentence Type ( $\chi^2(1)=1.603$ ,  $p=0.206$ ), Language ( $\chi^2(2)=3.421$ ,  $p=0.181$ ) and their interaction ( $\chi^2(2)=0.177$ ,  $p=0.915$ ) were all not significant.

**Integration window** - Significant Intercept ( $\beta=3.036$ ,  $SE=0.168$ ,  $z=18.084$ ,  $p<.001$ ) again indicated an overall higher likelihood of fixating on factual than illusory. The model predicted even higher probabilities of fixating on factual (>90%) for all conditions. The effect of Sentence Type ( $\chi^2(1)=0.219$ ,  $p=0.640$ ) and the interaction ( $\chi^2(2)=0.232$ ,  $p=0.890$ ) were still not significant, but there was a significant effect of Language ( $\chi^2(2)=7.058$ ,  $p=0.029$ ). Polish elicited significantly higher probabilities of looks to factual than Ukrainian ( $est=0.940$ ,  $SE=0.377$ ,  $z=2.498$ ,  $p=.034$ ). Contrasts Polish vs. Russian and Russian vs. Ukrainian were not significant.

**Divergence-points** - Factual looks diverged from illusory looks significantly later in negative than affirmative sentences for Polish and Ukrainian. For Russian, there was no significant difference.

## Conclusions

- Pol, Rus, and Ukr listeners shifted gaze to the factual state shortly after negation → evidence for a **one-step model**.
- Lower probability of fixating factual in the integration window in Ukr (and partly Rus) reflects **aspectual semantics**, not a language-specific two-step negation mechanism. Pol PFV past: focus on *event occurrence*. Ukr/Rus PFV past: stronger anchoring to *reference time* and *process-to-result transition*. → Stronger co-activation of process/result representations in Ukr/Rus → prolonged competition between factual and illusory images.
- Lack of neg-related delay in Russian possibly reflects predictive processing enabled by early prosodic differences between aff/neg sentences (more research needed).