

# How visual cognition influences process model comprehension



Razvan Petrusel, Jan Mendling, Hajo A. Reijers.  
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# Once upon a CAISE in time



# They were all there

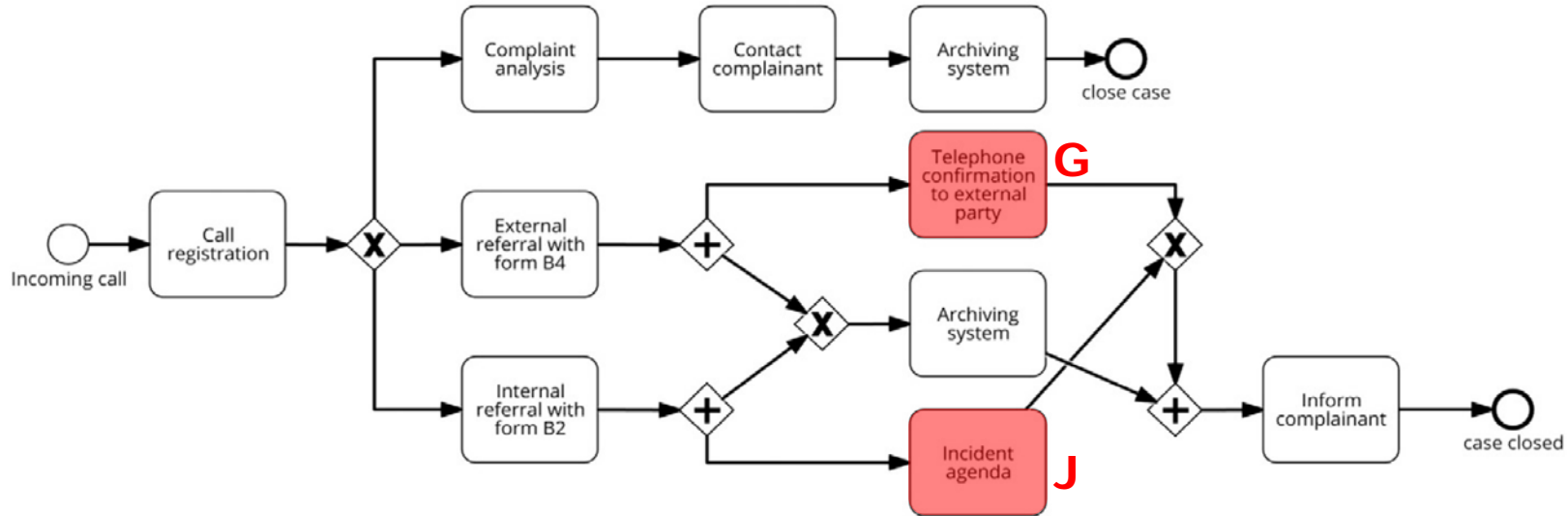




# A long journey



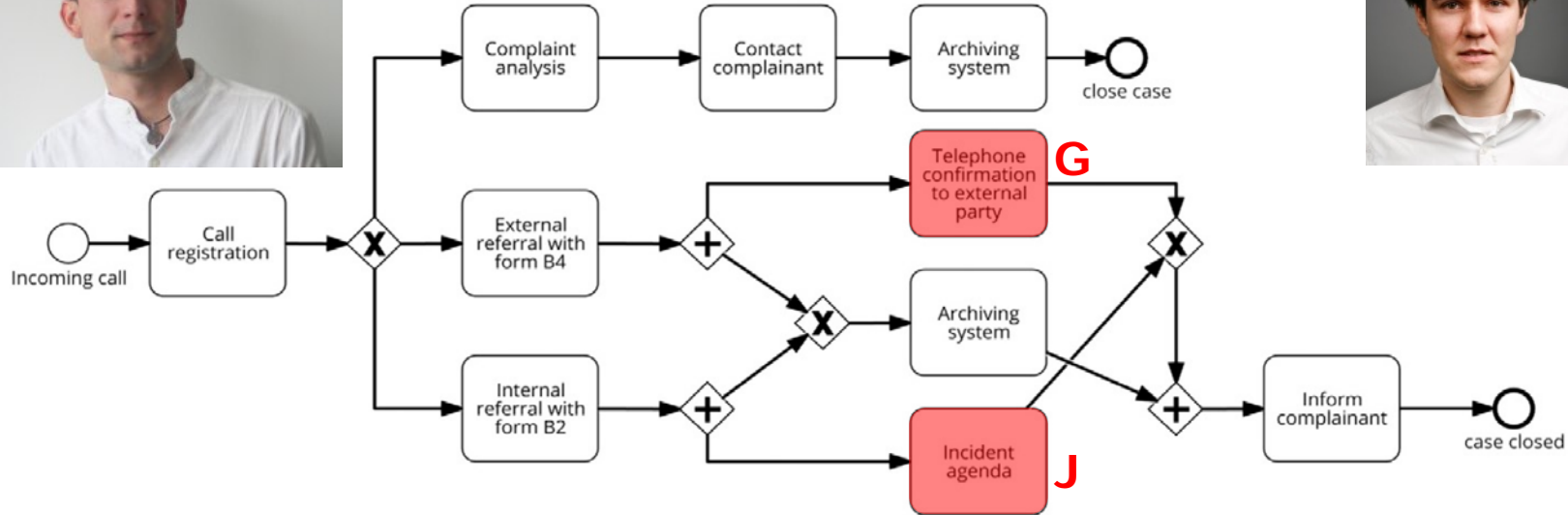
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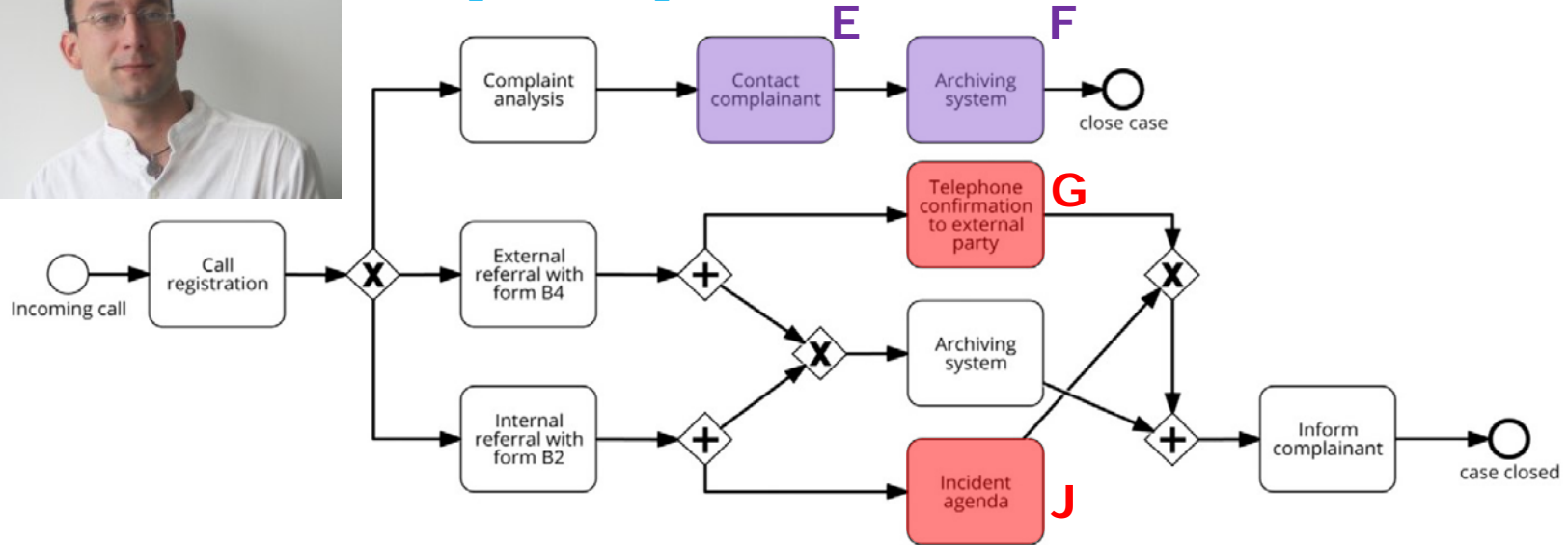
It depends upon the modeler?



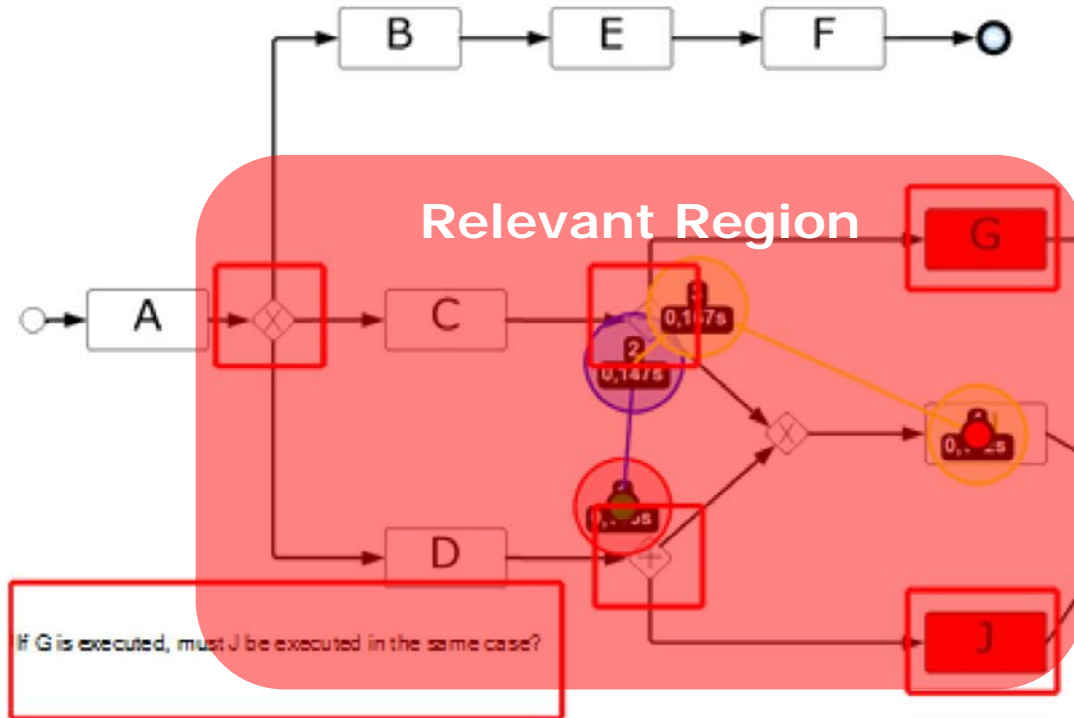
# If **G** is executed, must **J** be executed in the same case?



It depends upon the model?



# Let us find out with Eye-Tracking



Visual Cognition Efficiency

- Total Fixations
- Total Duration of Fixations

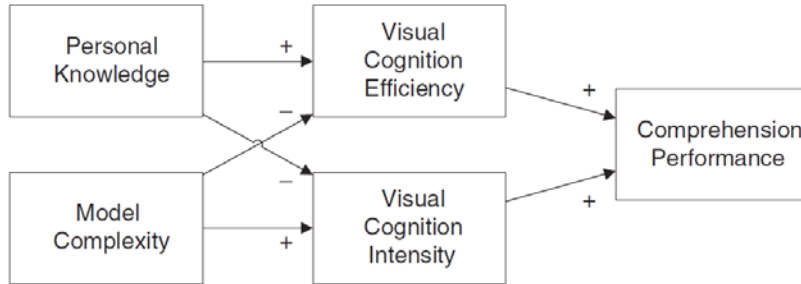
Visual Cognition Intensity

- Scan Path Precision
- Scan Path Recall





# Experimental Research Model



- H1. Higher Personal Knowledge and lower Model Complexity => better Visual Cognition Efficiency (measured by Total Fixations and Total Duration of Fixations).
- H2. Lower Personal Knowledge and higher Model Complexity => higher Visual Cognition Intensity (measured by Scan Path Precision and Recall).
- H3. A Visual Cognition Efficiency (measured by Scan Path Precision and Recall) and Visual Cognition Intensity (measured by Total Fixations and Total Duration of Fixations) model better explains comprehension performance (higher Correctness, higher Efficiency, lower Duration) than a Personal Knowledge and Model Complexity model.
- H4. The effect of Personal Knowledge on comprehension performance is mediated by Visual Cognition Efficiency and Intensity.
- H5. The effect of Model Complexity on comprehension performance is mediated by Visual Cognition Efficiency and Intensity.

# Summary of Results

Hypothesis	Performance dimension	Explanatory power	Support
H1	Total Fixations	0.1189	Supported
H1	Total Duration of Fixations	0.1336	Supported
H2	Scan Path Precision	0.0236	Partially supported
H2	Scan Path Recall	0.0499	Supported
H3	Correctness	Increase in Explanatory power: difference of $R^2$ Visual Cognition model– $R^2$ Literature model – 0.033 = (0.032–0.065)	Not supported
H3	Duration	Increase in Explanatory power difference 0.782 = (0.882–0.100)	Supported
H3	Efficiency	Increase in Explanatory power difference 0.249 = (0.359–0.110)	Supported
H4	Correctness	Familiarity mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported
H4	Duration	Familiarity mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported
H4	Efficiency	Familiarity mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported
H5	Correctness	Elements mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported
H5	Duration	Elements mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported
H5	Efficiency	Elements mediated by Total Fixations, Total Duration of Fixations, SPP, and SPR (each $p < 0.01$ )	Supported

# H1. Higher Personal Knowledge and lower Model Complexity leads to better Visual Cognition Efficiency

## H2. Lower Personal Knowledge and higher Model Complexity higher Visual Cognition Intensity

Dependent	Independent	Beta	S.E.	t-test	Sig.
Total Fixations	Constant	76.2617			
	Elements	1.0699	1.7664	8.111	<0.0001
	Familiarity	− 14.3266	0.1874	5.709	<0.0001
	F = 48.5828	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.1189		
Total Duration of Fixations	Constant	17.7203			
	Elements	0.2194	0.0419	5.235	<0.0001
	Familiarity	− 3.6332	0.3950	9.197	<0.0001
	F = 55.3630	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.1336		
Scan Path Precision	Constant	0.2985			
	Elements	− 0.0022	0.0006	3.633	<0.0003
	Familiarity	0.0140	0.0060	2.460	<0.0014
	F = 9.5107	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.0236		
Scan Path Recall	Constant	0.8533			
	Elements	− 0.0026	0.0010	2.616	<0.0091
	Familiarity	− 0.0518	0.0092	5.639	<0.0001
	F = 19.5188	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.0499		

# H3. Regression with Visual Cognition better explains comprehension performance than Knowledge and Model Complexity

Dependent	Independent	Beta	S.E.	Wald-Sig.	p
Correctness	Constant	− 0.034027	0.38529	0.007800	0.9296
	Familiarity	0.52082	0.12344	17.8019	<0.0001
	Elements	0.031210	0.012199	6.5456	0.0105
	Chi <sup>2</sup> = 25.340	Sig. < 0.0001	Nagelkerke R <sup>2</sup> = 0.06456		
Correctness	Constant	1.15019	0.30417	14.2995	0.0002
	Total Duration of Fixations	− 0.031422	0.011006	8.1514	0.0043
	Scan Path Recall	1.74891	0.53631	10.6342	0.0011
	Chi <sup>2</sup> = 10.3906	Sig = 0.002	Nagelkerke R <sup>2</sup> = 0.03198		

Dependent	Independent	Beta	S.E.	t-test	Sig.
Duration	Constant	28.9640			
	Elements	0.4871	0.07517	6.481	<0.0001
	Familiarity	− 4.3221	0.7085	− 6.100	<0.0001
	F = 39.09055	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.09752		
Duration	Constant	9.0507			
	Scan Path Precision	− 3.7742	1.8654	− 2.023	0.0434
	Scan Path Recall	− 6.1879	1.2576	− 4.921	<0.0001
	Total Duration of Fixations	− 1.0954	0.1134	− 9.657	<0.0001
	Total Fixations	0.6215	0.02604	23.867	<0.0001
	F = 131,314.89	Sig. < 0.001	Adjusted R <sup>2</sup> = 0.8817		



**H4. The effect of Knowledge on comprehension performance is mediated by Visual Cognition.**

**H5. The effect of Complexity on comprehension performance is mediated by Visual Cognition.**

Dependent variable (Y)	Independent variable (I)	Mediating variable (M)	MR	SR	SM	$B_{indirect}$	Sobel test (p value)
Correctness	Elements	Total Fixations	$Y = 0.806 + 0.0042 I + (-0.0005) M$	$Y = 0.7884 + 0.0037 I$	$M = 38.954 + 1049 I$	-0.0005	5202.4 ( $<0.01$ )
		Total Duration of Fixations	$Y = 0.807 + 0.0042 I + (-0.0023) M$	$Y = 0.8835 + 0.0037 I$	$M = 18.561 + 0.149 I$	-0.0005	7968.7 ( $<0.01$ )
		Scan Path Precision	$Y = 0.728 + 0.0041 I + 0.18 M$	$Y = 0.8835 + 0.0037 I$	$M = 0.335 + (-0.002) I$	-0.0004	8304.9 ( $<0.01$ )
		Scan Path Recall	$Y = 0.691 + 0.0041 I + 0.136 M$	$Y = 0.8835 + 0.0037 I$	$M = 0.718 + (-0.002) I$	-0.0004	10,172 ( $<0.01$ )
Correctness	Familiarity	Total Fixations	$Y = 0.707 + 0.05916 I + 0.00004 M$	$Y = 0.711 + 0.05862 I$	$M = 97.797 + (-14.19) I$	0.00054	52.82 ( $<0.01$ )
		Total Duration of Fixations	$Y = 0.710 + 0.05875 I + 0.000003 M$	$Y = 0.711 + 0.05862 I$	$M = 22.136 + (-3605) I$	-0.00013	8.32 ( $<0.01$ )
		Scan Path Precision	$Y = 0.683 + 0.057 I + 0.112 M$	$Y = 0.711 + 0.059 I$	$M = 0.254 + 0.013 I$	-0.002	897.5 ( $<0.01$ )
		Scan Path Recall	$Y = 0.569 + 0.068 I + 0.177 M$	$Y = 0.711 + 0.059 I$	$M = 0.802 + (-0.052) I$	-0.009	883.1 ( $<0.01$ )

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