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Appendix A

This is the causal part of the domain (the i-proposition and c-propositions) for the example in Section 5.3. It assumes that the subject is initially fully engaged and doing the task correctly. An event of type *LowValence* causes the level of *Engagement* to drop, whereas *TaskCorrect* is negatively affected by *BadPosture* and *EyesNotFollowingTarget* events. Since PEC-RUNTIME can also model concurrent actions, the effect of multiple events happening at the same time can also be modeled. In our scenarios, we assume that there are some (negative) synergies when multiple (distinct) events happen at the same time. Furthermore, when none of the previous activities is detected by the sensors, the value of *Engagement* and *TaskCorrect* grows.

initially-one-of $\{(\{Engagement = true, TaskCorrect = true\}, 1)\}$

$\{EyesNotFollowingTarget = false, LowValence = false, BadPosture = false\}$
causes-one-of
$\{(\{TaskCorrect = true, Engagement = true\}, 4/10),$
$(\{\}, 6/10)\}$

$\{EyesNotFollowingTarget = true, LowValence = false, BadPosture = false, Engagement = true\}$
causes-one-of
$\{(\{TaskCorrect = false, Engagement = false\}, 3/100),$
$(\{TaskCorrect = false\}, 17/100),$
$(\{\}, 8/10)\}$

$\{EyesNotFollowingTarget = true, LowValence = false, BadPosture = false, Engagement = false\}$
causes-one-of
$\{(\{TaskCorrect = false\}, 3/10),$
$(\{\}, 7/10)\}$

$\{EyesNotFollowingTarget = false, LowValence = true, BadPosture = false\}$
causes-one-of
$\{(\{Engagement = false\}, 3/10),$
$(\{\}, 7/10)\}$

$\{EyesNotFollowingTarget = true, LowValence = true, BadPosture = false\}$
causes-one-of
$\{(\{TaskCorrect = false, Engagement = false\}, 4/10),$
$(\{\}, 6/10)\}$

$\{EyesNotFollowingTarget = false, LowValence = false, BadPosture = true\}$
causes-one-of
$\{(\{TaskCorrect = false, Engagement = false\}, 3/100),$
$(\{TaskCorrect = false\}, 17/100),$

$(\{\}, 8/10)\}$

$\{EyesNotFollowingTarget = true, LowValence = false, BadPosture = true\}$
causes-one-of
$\{(\{TaskCorrect = false, Engagement = false\}, 1/10),$
$(\{TaskCorrect = false\}, 3/10),$
$(\{\}, 6/10)\}$

$\{EyesNotFollowingTarget = true, LowValence = true, BadPosture = true\}$
causes-one-of
$\{(\{TaskCorrect = false, Engagement = false\}, 3/10),$
$(\{TaskCorrect = false\}, 2/10),$
$(\{\}, 5/10)\}$

Appendix B

This appendix proves the following proposition[6]:

Proposition 7.1
Let $\mathscr{D}$ be any domain description such that $\mathscr{D} = \mathscr{D}_{\leq 0}$. Then, $M_{\mathscr{D}_{>0}}(\varphi) = M_{\mathscr{D}}(\varphi)$ for any i-formula φ having instants > 0.

Proof
Since $\mathscr{D} = \mathscr{D}_{\leq 0}$ the entire narrative of $\mathscr{D}$ (possibly) occurs at 0. Let φ be a formula that only has instants > 0. According to PEC's semantics,

$$M_{\mathscr{D}}(\varphi) = \sum_{W \| \models \varphi} i(W) \varepsilon_{\mathscr{D}}(W) t_{\mathscr{D}}(W(0), W(>0)) \tag{34}$$

where $i(W)$ is the initial probability of the state in W, $\varepsilon_{\mathscr{D}}(W)$ is the probability of occurrence of the narrative in W, and $t_{\mathscr{D}}(W(0), W(>0))$ is the probability of transition from the state $W(0)$ to $W(>0)$.

Since the formula φ only has instants > 0 we can group together worlds by their state at 1. That is, we construct equivalence classes $[W]$ such that $W' \in [W]$ if $W'(1) = W(1)$. Since $\mathscr{D}$ has no narrative occurring at instants > 0, well-behaved worlds W w.r.t. $\mathscr{D}$ are such that $W(I+1) = W(I)$ for all instants $I > 0$ due to persistence. Since φ only has instants > 0, if a world $W' \in [W]$ is such that $W' \| \models \varphi$ then also $W \| \models \varphi$, since W and W' can only possibly differ at 0. Then, Equation (34) continues as follows:

$$= \sum_{[W] \| \models \varphi} M_{\mathscr{D}_{>0}}([W]) = M_{\mathscr{D}_{>0}}(\varphi)$$

by definition. □

[6] The notation used in this proof follows (D'Asaro et al. 2017) and (D'Asaro et al. 2020).