



Playing hide and seek without perspective taking

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Hide and Seek



- How do children learn to play hide and seek?
- Specifically, how do children learn to hide?
- Very young children can play peek-a-boo

Perspective taking ability?



- A “good” hider needs perspective taking to find the good hiding places
 - Hiding behind an object from the perspective of “It”
 - Where will “It” look for me first? (obvious places vs. not obvious places)
 - Just because I can’t see “It” doesn’t mean “It” can’t see me...
 - Keeping an object in between “it” and the hider (while moving...)

Development of Perspective-Taking



- Children start developing (very very basic) perspective-taking ability around age 3-4
 - Huttenlocher & Presson, 1979; Newcombe & Huttenlocher, 1992; Wallace, Alan, & Tribol, 2001
 - (Piaget and Inhelder, 1948 said even children 8-9 years old didn't have perspective taking ability)

Development of Perspective-Taking



- Children start developing perspective-taking ability around age 3-4
 - Perspective taking studied in the lab is usually quite simplified: photograph of one of four different perspectives
 - 67% of the time, 4 year olds made correct “near-far” perspective taking decisions (and this is good, or at least better than chance...), Newcombe & Huttenlocher, 1992, exp. 2
 - 27% of the time, 4 year olds make left-right perspective-taking errors (exp. 2) (about chance level)
 - If you add an additional environmental cue, performance on left-right goes up to 53% (exp. 3)

Perspective taking in hide and seek



- Hide and seek seems rather more complicated than most simple experimental perspective-taking tasks
 - Large-scale environment (i.e., can't see entire area all at once)
 - "It" viewpoint (i.e., where will "it" be when coming into this room/area?)
 - Will this object be big enough for me to get inside of/hide behind?
 - Lots of things to worry about other than perspective taking (i.e., time pressure; lots of objects; lots of locations)

Hide and Seek



- YET even at 3-4 they can play a credible game of hide and seek, even in novel environments!
 - Anecdotal evidence only (but lots of it!)
- If 3-4 year old children don't have good perspective taking ability, how do they learn to play hide and seek well?
- There are no studies (that I've found) that deal with naturalistic hide and seek tasks
 - Most deal with laboratory studies
 - There may be theories or models, but I can't seem to find them (plea for help)

Hide and seek



- Basic hypothesis: Since perspective taking isn't learned until later; 3-4 year old children play hide and seek by learning pertinent features of objects
 - Opaque/Transparent (Can or can not see through)
 - Size (big enough to get inside of)
 - (Probably learning familiar "good hiding place" object locations, also...)

Hide and seek



- 3-4 Year old children must construct knowledge about hiding that is object-specific
 - Hiding inside an object is good if it is opaque
 - Hiding far away from “It” is good
 - Hiding under clear things isn’t so good
 - Hypothesis: Hiding “behind” something (without peaking) will happen only rarely because that requires some perspective taking
 - If it does happen, it will probably happen (only?) in a very familiar environment
 - This could be a simple “if I can’t see you, you can’t see me” heuristic, at least at the beginning, though this doesn’t seem to be the whole story

Challenges



- Build ACT-R model of 3.5 year old playing hide and seek
 - A hiding place must be found in less than 10 seconds (1, 2, ...10)
- Put this model on a robot (!) so robot can play hide and seek
 - Allow ACT-R to really “See” the world (through sonar sensors...)
 - No PM in robot mode!
 - Embodied ACT-R
 - (Some research challenges, some engineering challenges)

Hide and seek case study



- About 6 months ago, I played hide and seek with my (then) 3.5 year old daughter (Elena)
 - Elena had not played many games of hide and seek
 - I video-taped all hiding places, our (verbal) interactions, etc. every time we played throughout the day
 - All normal caveats about case studies (especially with your own child!)
 - But the data is a great starting place for this model
- At 3.5 Elena did not seem to have full perspective taking ability (still made some left/right errors)
 - Facing me, “Which hand is my right?”

Hide and seek case study



- In one day, we played about 7 games:
 - First two games: Elena hid with her eyes closed/hid out in the open (stuck in local minima?)
 - I offered her a suggestion: “Don’t hide out in the open”
 - Next she hid under our piano (using my advice)
 - A few games later she was hiding under sheets, under apolstered chairs, etc. (very good hiding places)
- Sometimes she received feedback:
 - “I see you”
 - “That’s a very good/much better hiding place”
- Once she received a suggestion (above)

ACT-R Trace (Game 1-2)



“Let’s play hide and seek” (Elena had not had much experience playing hide and seek before)

;; because of robot issues, there is LISP setup
(play-and-run-hide-and-seek) ;; game 2

Time 2.200: Setup-Hide-And-Seek Selected

I HAVE BEEN ASKED TO PLAY HIDE AND SEEK!

Time 2.250: Setup-Hide-And-Seek Fired

Time 2.250: Hide-And-Seek-Find-It-Room Selected

Time 2.300: Hide-And-Seek-Find-It-Room Fired

Time 3.300: Hide-And-Seek-Plan-New-Room

Selected

Time 2.721: Kit Retrieved

IT IS IN THE Kitchen SO I WILL HIDE IN THE Music-Room

Time 3.350: Hide-And-Seek-Plan-New-Room Fired

Time 4.350: Hidegoal Retrieved

Time 4.350: Close-Eyes Selected

I WILL CLOSE MY EYES!

Time 4.400: Close-Eyes Fired

ACT-R Trace (Suggestion)



Here I said "You might not want to hide in the open"

(play) ;; Interlude

(offer-suggestion-to-not-hide-in-open)

<Model thinks about what "open" means>

<Model thinks about specific objects and what "not out in the open" means: under, behind, or inside an object>

<Model tries to apply the "not out in the open" heuristic to available objects so it can hide in a better place in the future>



ACT-R Trace (Game 3)



(play-and-run-hide-and-peek)

Time 23.848: Setup-Hide-And-Seek Selected

I HAVE BEEN ASKED TO PLAY HIDE AND SEEK!

Time 23.898: Setup-Hide-And-Seek Fired

Time 23.898: Hide-And-Seek-Find-It-Room Selected

Time 23.948: Hide-And-Seek-Find-It-Room Fired

Time 24.948: Hide-And-Seek-Plan-New-Room Selected

Time 24.378: Kit Retrieved

IT IS IN THE Kitchen SO I WILL HIDE IN THE Music-Room

Time 24.998: Hide-And-Seek-Plan-New-Room Fired

Time 25.998: Hidegoal Retrieved

Time 25.998: Hide-And-Seek-Get-Knowledge Selected

Time 26.048: Hide-And-Seek-Get-Knowledge Fired

Time 27.048: Hidegoal Retrieved

Time 27.048: Find-Object-To-Hide-Around Selected

Time 27.098: Find-Object-To-Hide-Around Fired

Time 28.098: Goal5 Retrieved

Time 28.098: Found-Object-To-Hide-Around Selected

I WILL HIDE Under THE Piano1

Time 28.148: Found-Object-To-Hide-Around Fired



:: Model has used previous reasoning about what “not out in the open” means to hide “not out in the open”

:: Feedback is subtle: “I can still see you”

:: Model does some reasoning about “good” and “poor” places to hide based on this feedback

ACT-R Trace (Game 7)



Additional games...

Model (and Elena) receives feedback about whether or not it can be seen

Model thinks about opaque/transparency issues

:: Game #7

I have an ACT-R version 4 that solves this; almost have a version 5

Model learns features of objects (opaque/can see-through and uses those features to make decisions about good hiding places



Elena hid up the stairs, in a bedroom, under a covered chair; it took me forever to find her. This is a great hiding place.

Model Learning



- Model goes through several types of learning:
 - New chunks about hiding that are used to help it hide (specifically, when thinking about what “not out in the open” means)

```
=piano-hide-knowledge443>  
isa hide-info  
  object-name pinao1  
location-not-in-open under  
status search
```

- Model gets feedback: you hid well (or not) so I have to update some production success
- Model has to think about objects (is big and opaque a good thing to hide inside of?)

Problems/Issues with model: productions



- Thinking and reasoning is hard!
- How do I think about the suggestion “don’t hide out in the open”?
 - Currently, I iterate over objects and create new chunks based on what model knows about “not out in the open” means
 - I have productions already there, waiting for the hide and seek “do not hide out in the open” suggestion, even though the model has no experience with them yet
 - How in the world did those (no previous use?) productions get created?

Problems/Issues with model: status slots



- Status slots in chunks vs. goal activation
 - How do I pick the next object around which to hide?
- IF I am playing hide-and-seek AND
I know not to hide out in the open
THEN retrieve/look for an object around which to hide
- If I use perceptual/vision system (even robot-vision system) I can pick randomly (?) what object I look for.
 - Sometimes I can't see the object I hide under (covered chair)
 - However, if I use memory/retrieval mechanism, that object gains activation so the next time I play it will be active and I will want to pick it again...
 - After I hide once, I probably don't want to hide in the same place again (even Elena doesn't hide in the same place 5 times in a row; deliberate strategy? Don't know)

Problems/Issues with model: status slots



- Possible solution: Status slots
=piano1 > isa object
status hid-behind-recently
- ICK
- This solution then needs to be cleaned up after so long (i.e., I need to set status to not-hid-behind-recently)
- After playing a few games, it doesn't seem like slot status knowledge; rather it seems like I have a sense for the most recent hiding place(s) via activation (similar to Altmann & Trafton, 2002)
- Not clear decay + noise will really do the trick

Summary



- Current hide and seek model does match learning behavior and hiding behavior/strategies of case study (at least at qualitative level)
- No perspective taking, and it does play a credible game of hide and seek
- I'm using lots of different types of learning in this model (and it works pretty dang well)
- Will have initial version on robot in ~ 1 month

Summary



- Where do “history-less” productions come from? May be wrong representation (?)
- Status slots vs. activation of chunks to keep track of different types of knowledge (goal knowledge, “did I hide there last time”, etc.)