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
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)
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)
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)
• 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...)
• 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)
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?”
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 upholstered 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)
“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
Here I said “You might not want to hide in the open”

(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>
(play-and-run-hide-and-seek)
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

;; 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
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)

```plaintext
    piano
  isa hide-info
    object-name piano
    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.)