IMPRINT models of training:  
Update on RADAR modeling

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Summary of IMPRINT effort

• Previous Progress
  – Digit Data Entry
    • Model was finished – relatively simple model
    • Replicated in Matlab by Bengt with parameter optimization
  – RADAR, Experiment 1
    • Modeling just begun, very small subset modeled (RT only, no-tone only, first session only)
    • Relatively complex set of data compared to Digit Data Entry

• RADAR modeling progress in the past year
  – At request of MURI team, explored possibility of using existing IMPRINT learning/training plug-in and user-developed stressors (neither proved useful in this model)
  – Analysis of all data at the frame level; reclassification of some data leading to reanalysis at shift (trial) level and a deeper understanding of the data (especially the accuracy measures)
  – Addition of second session, tone counting condition, and hit rate
RADAR screen (Exp. 1)

blips go from corners to center in 2.062 s
Goals in modeling RADAR in IMPRINT

• Important factors to be modeled:
  – **Mapping type** (are targets and distractors from same or different character set)
    • **CM** (“consistent mapping”) – different set: if targets are digits, distractors are letters *(or vice versa)*
    • **VM** (“varied mapping”) – targets and distractors are from same character set
  – **Load level** (number of items in target memory set AND number of items to look at to see if target)
    • **1-1**: only 1 target to memorize/look for; only 1 blip has character
    • **4-4**: 4 targets to keep in memory; all 4 blips have characters and must be looked at
  – **Tone counting** (Subject counting deviant tones as secondary task vs. absence of secondary task)
    • Between subject: tone counting at training crossed with tone counting at test
Additional notes to previous slide
(this slide not in presentation)

- The factors of Mapping type and Load level were varied within subject and crossed, giving 4 distinct shift or trial types.

- The third major factor, the secondary task of tone counting, in this experiment plays an important and contrary role in trying to understand the Training Difficulty Principle.
Further things to be modeled

- Interactions of those variables (mapping, load, tone counting) within a session
- Interactions of those variables across sessions
The basic RT patterns in RADAR

Notes: averaged over session, block within session, and tone group. RTs are for hit (correctly recognized target) trials only.
Description of graph on preceding slide (this information was not on a slide but included here to make previous slide clear)

- Basic RT patterns
  - CM faster than VM
  - 1-1 faster than 4-4
  - Similar pattern in Training and Test
    - No learning observed in RT
  - CM 1-1 and VM 1-1 very similar, and fastest; CM 4-4 somewhat slower; VM 4-4 much slower

- The basic things that go into the times for the four trial types are:
  - The time to press the space bar
  - The time spent moving the eyes to one or more blips, and
  - The time to recognize the character enough to make a decision and to make that decision

- Times for eye movements and pressing the space bar were based on values in IMPRINT micromodels.
Assumptions for RT components

• CM tasks, VM 1-1 task, and VM 4-4 task are different from each other
  – CM 1-1 and 4-4: Is character in blip in right character set? Only difference is looking at more blips in 4-4 condition
  – VM different from CM: Distractors in same character set as targets, so have to identify actual character
  – VM 4-4 different from VM 1-1: Must compare each blip looked at with each of 4 items in memory set

• Self-terminating search
• On average, total time for eye movement is similar between the 1-1 and the 4-4 conditions
• Pressing space bar is FAST
Simplified version of network

Prepare for next frame

Move eye to next blip

Is this in the right char set

Is this the target

Is this in the memory set

Press space bar

Are there more blips to look at

Wait for next frame

CM

VM 1-1

VM 4-4

YES!!

NO

yes

no
Subjects vs. Model
(averaged over tone)

$r^2 = .982$
Additional Factor: Tone counting

• In **Tone** condition, tones occur every 500-1500 ms
  – Approx 15% are “deviant” – these must be counted and count reported at end of shift
    • “deviant” tones are recognizably different from base tone
• In **No Tone** condition, no tones are heard
• Between subjects
  – Crossed between sessions
  – 4 groups
    No Tone-No Tone (NN)       Tone-No Tone (TN)
    No Tone-Tone (NT)         Tone-Tone (TT)

As a secondary task, tone counting is a test of the Training Difficulty Principle
RT tone counting subject results

- The secondary tone counting task results in longer response times
- Tone counting at training (compared to no tone counting at training) results in longer response times at test for both tone counting conditions at test (esp. in VM shifts)
  - This result is counter to other findings (supporting the Training Difficulty Principle) that difficulty at training leads to better learning (presumably due to concurrent distraction in this experiment)
Modeling tone

- Penalties for
  - Secondary task in general
  - When a tone is heard (interruption of concentration)
  - When the tone is deviant and the count must be incremented
  - (In test) having trained with tone
Subjects vs. Model

Test session; similar pattern in training session

$r^2 = .982$
Additional notes to previous slide
(this slide not in presentation)

- Previous slide shows test session; in the training session the same pattern is seen for the first finding, that the secondary task resulted in longer response times.
- To see the basic effect of tone counting, note that in every side-by-side pair of subject bars the bar with tone is higher than the bar with no tone.
- To see the effect of training with tone on performance at test, compare the light blue and green bars in each group of 8 bars that represent one shift type. The pair of bars on the right are the subjects that trained with the secondary task; the pair of bars on the left are those who did not. In every case, the pair on the right have RTs that are slightly longer than those on the left, and this difference is significant.
- IMPRINT captures both of these results very well (compare the dark green and blue columns with each other and the light green and blue bars).
Accuracy

- Two components to Accuracy
  - Hit rate (HR)
    - Just finished working with HR (current model $r^2 = .907$)
    - CM and VM 1-1 similar; VM 4-4 far worse
    - Training with tone also results in worse HR performance at test
  - False Alarm rate (FA)
    - More complex patterns than HR
    - Some subtle learning patterns found in FA
What’s next

• False Alarm Rate, including the more subtle effects (such as learning)
• Bengt will recreate IMPRINT model in Matlab
  – Use numbers for variables provided from the Matlab model to fine-tune IMPRINT model
• Potential for use in making predictions for follow-on experiments
  – Some experiments have already been done and reported here
The hidden slides following this one are the background slides describing the RADAR Task in Experiment 1 of the RADAR series of experiments
Summary – Overall Experiment

Experiment takes place in 2 sessions (Training, Test) one week apart

1 Block = 20 Shifts

1 Shift = 7 frames

“Shift” = Trial

Each session = 8 blocks
Each block has trial type as noted (explained shortly)

CM 1-1
CM 4-4
VM 1-1
VM 4-4
VM 1-1
CM 1-1
CM 4-4
CM 1-1

(20 of these)
Summary – The shift

• 15 out of 20 shifts have a target, 5 have no target
• 7 frames per shift
• Frames 1 and 7: all 4 blips are blank
• Target occurs once in shift, distributed across frames 2-6; distractors also in frames 2-6 as required by shift type
• Each shift has its own target memory set from allowable set of targets – different every shift
Summary – Trial type factors

• Target set (digit vs. letter; no effects, so ignored)
  – Between subject; same for a given subject in both sessions

• Mapping
  – Consistent (CM): distractors are different character set than target
  – Varied (VM): distractors are SAME character set as target
    • Crucial: Sometimes a target is a distractor in other shifts

• Number of targets in memory set/number of filled in blips
  – 1 or 4
  – referred to as Load or load level in presentation

• Mapping and number of targets:
  – Within Subject
  – Crossed ➔ CM1-1, CM4-4, VM1-1, VM4-4
Summary – The Frame

• 4 blips, either blank or with letter or digit
• Blips move from outer corners to center in 2.062 s
• Subject to respond as quickly as possible if target present, otherwise should not respond

An example of a CM 4-4 frame with target present
Summary – How trial types correspond to frames: CM 1-1

for sake of example, targets are digits

• 1 digit to remember as target
• Only one blip has any character, rest blank
• In target frame, target digit will be shown
• In non-target frames, **letters** will be shown (because CM condition)

**THEREFORE:** **Easy:** Eyes go to filled in blip, just have to decide if it is a letter or a digit – don’t even need to check actual identity
Summary – How trial types correspond to frames: CM 4-4

_for sake of example, targets are digits_

- 4 digits to remember as targets, but **only one** can actually occur in that shift
- All 4 blips have a character; all are distractors except when target is shown
- In target frame, target digit will be shown, rest of blips are letter distractors (because of CM condition)
- In non-target frames, **letters** will be shown (because CM condition)
- THEREFORE: **Relatively easy**: Eyes go to each blip in turn, just have to decide if it is a letter or a digit – don’t even need to check actual identity. If it IS a digit, then respond, otherwise go to next blip or wait for end of frame.
- Takes more time than 1-1 case because have to look at up to 4 blips (**avg. 2.5/frame in target frames**), but pretty much same task
Summary – How trial types correspond to frames: VM 1-1

for sake of example, targets are digits

• 1 digit to remember as target
• Only one blip has any character, rest blank
• In target frame, target digit will be shown
• In non-target frames, digits not from the memory set will be shown (because VM condition)

• THEREFORE: Relatively easy: Eyes go to filled-in blip, have to decide if the character is the same as the target

We know VM 1-1 is pretty much as easy as CM 1-1, at least in this experiment, because RT and accuracy have extremely similar values between the two, esp. RT
Summary – How trial types correspond to frames: VM 4-4

for sake of example, targets are digits

- 4 digits to remember as targets, but only one can actually occur in that shift
- All 4 blips have a character; all are distractors except when target is shown
- In target frame, target digit will be shown, rest of blips (distractors) are also digits, but not from memory set (because of VM condition)
- In non-target frames, digits not from memory set will be shown (because VM condition)
- THEREFORE: Relatively difficult: Eyes go to each blip in turn, have to decide if that character is one of the 4 items in the memory set
- Takes more time than 1-1 case because have to look at up to 4 blips (avg. 2.5/frame in target frames), AND have to compare against 4 items in memory set instead of 1