Summary of Bejjani/Egner Article:

Key points:

- Thesis:
  - Cognitive control (i.e. how manipulation of attention states influences learning) has usually been seen in antithesis to associative learning (i.e. contingency learning/learning stats of S/R feature relationship)
  - But, these two mechanisms can work together e.g. learn to associate stimuli with attentional state
- Experiment 1+3: learned stimulus control association transfers across pre-learned stimulus associations (i.e. transfer effect)
  - Exp. 1
    - S1-S2 (2 stimuli linked e.g. face/house → scene)
    - S2 – Stroop task: *establishing attentional control states*
      - Half high control demand cues (e.g. incongruent)
        - Two S2 images mostly preceded incongruent trials?
      - Half low control demand cues (e.g. congruent)
        - frequency biased stimuli used (?)
          - differences in stimuli for incon/con, then contextual manipulation = control learning?
    - S2-CT: S1 images preceded Stroop, but not predictive of congruency/incongruency
      - Finding: even though there were no group level cueing effects in the S2-C phase (i.e. stimulus modulating Stroop performance), there was a transfer effect i.e. S1-C performance associated with S2-C
    - Additional finding: memory effects
      - Those who learned initial pairing associations S1-S2 (indicated by faster RTs), performed better in subsequent tasks
        - May suggest control learning possible, but could also have been due to contingency learning

  - Exp. 3: tackle how to make group level control learning effect in S-C, and increase effect size of experiment → make tweaks to experiment, to bring out control learning effect (S-C/S-CT set up different)
    - Tweak 1: strengthen S-C association by showing S2 images throughout trial (Stroop colour word shown below image) – e.g. saliency of the S1 to Control state
    - Tweak 2: increase time between colour of word and printed colour (set up of S-CT diff: colour of word shown first in black, and then colour/print word shown)
      - To control for contingency association confound, Stroop stimuli sectioned into frequency biased and unbiased items
        - Biased: RED/GREEN always incongruent (high demand cues), always congruent (low demand cues)
        - Unbiased: blue/yellow incong./cong. 50% time, not predicted by cue

Commented [chb1]: in expt 1, we used all possible combinations of a 4 Stroop color-word stimulus set.

RED-RED
GREEN-GREEN
YELLOW-YELLOW
BLUE-BLUE

RED-GREEN
RED-YELLOW
RED-BLUE
GREEN-RED
GREEN-YELLOW
GREEN-BLUE
YELLOW-RED
YELLOW-GREEN
YELLOW-BLUE
BLUE-RED
BLUE-GREEN
BLUE-YELLOW

these are not frequency biased so much as they are prone to contingency learning confounds as we talked about in the other doc.

So, in expt 3, we changed things-

RED-RED
GREEN-GREEN
YELLOW-YELLOW
BLUE-BLUE

RED-GREEN
GREEN-RED
YELLOW-BLUE
BLUE-YELLOW

One manipulation we made was that red would only ever appear in red or green (same for green), while blue and yellow would only ever appear in blue or yellow. This mostly controls for the feature integration effect, as we do not have to worry about "partial feature overlaps." Plus, now both the congruent and incongruent conditions have equal numbers of stimuli; in short, they'd have an equal likelihood of being affected by any sort of contingency or feature learning confounds.

The other component was that for the high demand cue in E3, red/green were always incongruent, while blue/yellow were 50:50, and that for the low demand cue, red/green were always congruent, while blue/yellow were 50:50. This makes red/green "frequency biased" while blue/yellow were "unbiased", nonpredictive, and therefore our way of testing whether participants truly learned that each cue is predictive of a certain proportion of demand (with this manipulation, you see how each cue ends up with a 75:25 proportion? each Stroop stimulus is presented equally in the task.)

Commented [chb2]: Not necessarily a subsequent task. It was just validating that people after the task were able to remember the pairings between each face/house and scene. And that that memory was related to their "validity" effects (faster RT when a specific face/house predicted its specific paired associate scene). Basically all that means is that our initial manipulation for paired associate learning worked the way we thought it did.

Commented [chb3]: contingency learning comes from the fact that we used the full Stroop stimulus set, not the memory findings

        - Questions: by having biased/unbiased frequency items, would unbiased Stroop items show S-C learning and S-CT transfer effect? (having unbiased probe means we can analyse data without contingency learning confounds)
            - ensured that control-demand cues mostly preceded their respective trial types at a 0.75 probability while also producing Bunbiased^ probe items (the blue/yellow stimuli) that indexed an effect of learned control in the absence of the confound of learned stimulus response associations.???? P. 7
            - Now that we increased Stroop conflict and showed the S2 control-demand cues for the entire duration of each trial, participants used these cues to modulate Stroop congruency for the frequency-unbiased stimuli (Fig. 2e; cue Å~ congruency: p.7 ???
                - Why for frequency unbiased stimuli?

- <u>Experiment 2</u>: transfer of control state association *depends on initial associations linking stimuli* (i.e. in line with context specific control settings generalising to new/unbiased stimuli)
    - Criticism of Exp. 1 is that transfer effects due to contingency learning → scramble S1-S2 associations
        - Control transfer hypothesis → no differential congruency effects found
        - Learned predictive account → there will be congruency effects (e.g. people can just learn stats in the individual S2-C and S2-CT trials)
            - Suggests mechanism is control-learning
- <u>Criticism</u>: mechanism is actually learned cue response vs. control
    - Look at Exp. 1 (S-C data) for refutation
    - Exp. 3 replication:
        - control-context learning in absence of contingency learning
        - only control learning transferred across stimuli; not S/R contingency learning

<u>Key terms</u>

- Probe items
    - In the Stimulus-Control Transfer (S-CT) phase, S1 "transfer probes" likewise preceded the onset of Stroop trials but were not predictive of congruency
- Transfer learning

<u>Questions</u>:

- “large amount of individual variability in S-C cueing effects) p. 4?
- Validly cued? (meaning cues that corresponded with attentional states vs. minority that didn’t?)
- What is “run sensitive transfer”? p. 4

Commented [chb4]: yes

you look at responses to unbiased stimuli for the particular contexts/scenes to see whether people learned the association between scenes and control states. Because the stimuli are nonpredictive/unbiased, then you can conclude that it's not the stimulus itself that caused the effect.

Commented [chb5]: exactly what you wrote!

Commented [chb6]: mmm so contingency learning is a critique of e1, but we ran e2 to "prove" that the effect was indeed due to the paired associates. That, essentially, it wasn't random. So it's not much to do with contingency learning as showing that our main manipulation - these three phases - is what is responsible for the effect. In other words, it is truly S1 -> S2 -> control-state ==== transfer.

Commented [chb7]: learned predictive account wouldn't suggest control-learning; it would suggest that it was just random

Commented [chb8]: yeah, sorry, we called them "probe items" but they're just nonpredictive 50:50 contexts from the first phase.

Commented [chb9]: yes, we found no group-level effect in the S-C phase, but found one in the S-CT phase. We also found a correlation between the S-C effect and the S-CT effect. That suggests that when learning contexts + control states, there is a lot of variability, which might "cancel" out when looking at it on a group-level and thus hide individual learning.

Commented [chb10]: in the first task phase, we ran a paired associates task or a variant of the posner cueing paradigm. What this means is that you have:

Face 1
Face 2
House 1
House 2

Face 1 will 8/10 of the time precede Scene 1. But for 2/10 of the time, it will precede Scene 2, 3, and 4. Face 2 will 8/10 precede Scene 2 and 2/10, precede Scene 1, 3, and 4. Etc. So, we call the 8/10 times "valid" trials - these are the scenes that the faces/houses are *actually* associated with -- while the 2/10 times are "invalid" trials - these are the scenes that the faces/houses are NOT associated with. The idea is that people will learn in time that Face 1 will most likely precede Scene 1. And their task is simply to categorize Scene 1 (e.g., they're told in the instructions, if mountain, press a; if canyon, press s, etc.). So, if they learn/realize that Face 1 precedes Scene 1 (mountain), then they can optimize their performance; when they see Face 1, they know a mountain is most likely coming and they will therefore respond more quickly and more accurately (most likely) to the coming mountain. They have only 750 ms to respond to the scene, so this information is useful to them.

Commented [chb11]: just means that the transfer effect would be present in run 1 but not in run 2. In other words, because it is not adaptive to recruit high attention for a contextual stimulus that is 50:50, by the time run 2 comes around, people will realize that (or learn that) these stimuli are non-predictive, so therefore, I don't need to pay more attention to the face/house stimuli that were associated with high demand scenes

- "surprisingly at the group level, we did not observe any evidence that participants used the S2 control-demand cues to modulate Stroop congruency?" (what does this mean?)
- validity effects: participants performed the correct task? P. 4
- "no interaction between run, control-demand cue, and congruency for RT"?
- S2 images act as goal-relevant outcomes in the S-S phase but predictive cues in the S-C phase?? (what does this mean?
- What is "run sensitive"

** Associative (contingency) not same as causal (control) learning

**Future experiments:

Future work should also examine whether people can transfer these control settings across different members of associated categories (cf. Cañadas et al., 2013), using trial-unique stimuli to control for priming effects and subsequently test for incidental encoding differences in the retrieval of control states. Control settings and retrieval may be further modulated on an individual level, prompting the need to pinpoint the optimal and boundary conditions for obtaining control-learning effects, which were highly variable in Experiment 1. Previous work has shown that individual differences in working memory capacity (Hutchison, 2011) and reward responsiveness (for review, see Braver, 2012) may modulate contextual control effects, while design considerations such as cue awareness (Farooqui & Manly, 2015) and timing

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- The difference in congruency for frequency-biased stimuli was smaller than congruency differences for frequency-unbiased stimuli following both the high-demand cues (t(43) = 3.34, p = 0.002, Cohen's d = 0.53, CL effect size = 69 %) and low-demand cues (t(43) =6.03, p < 0.001, Cohen's d = 1.01, CL effect size = 82 %). This suggests that participants learned stimulus-response associations, but that these associations did not drive our conditioned control-demand effect. P. 8

Commented [chb12]: we were looking for the interaction between control-demand cue (high/low) and congruency (incongruent/congruent). Basically, that the difference in congruency would be *smaller* following a high-demand cue vs. low-demand cue, because you will be recruiting a higher attentional control state following a high-demand vs. low-demand cue. So, here we are saying that at the group level, this does not appear to be the case. But as I said in a comment above, we tend to average across all participants, and that average can sometimes mask individual effects.

Commented [chb13]: see above

Commented [chb14]: interaction is a statistical term; see c12. Run was also in the model, because you can imagine that if participants learned this over time, it might slowly appear. Likewise, perhaps effects of exhaustion occur so participants show smaller congruency differences for high vs. low earlier and these then taper off towards the end of the task. Etc. etc. But we don't observe either scenario.

Commented [chb15]: In the first task phase, you are responding to the scenes. You are told to press A if it's a mountain; S if it's a canyon, etc. Therefore the scene aka S2 image is a part of your "task-goal" and it is also considered the "outcome" in a way because the predictive cue is the face/house aka S1 image. In the second phase, you are responding to the Stroop stimuli. You are told to press buttons according to the printed color, e.g., x if red, n if blue, etc. But the scenes predict the amount of hard vs. easy trials; they are "predictive cues" in that phase.

Commented [chb16]: see above, c11

Commented [chb17]: yep. Those were some suggestions for future experiments. Reward responsiveness is a part of proactive/reactive control and the Abrahamse review you read; working memory capacity is the number of items that you can hold in your mind at once (so perhaps learning these associations depends on how many associations you can keep in mind at once, etc.). We talk about pinpointing boundary effects - at what point do you no longer observe control-learning? etc.

Commented [chb18]: Yes, so you expect frequency biased stimuli to have a lower congruency difference than unbiased stimuli, because they're more potent and powerful contingency-wise. So, this is an expected finding - people did show that the "S-R" or contingency effect, assessed via the biased stimuli (where participants when they see high demand cue and it's "red", they know "green" is coming/the response needed, etc.), exists in this set. But we also observe the stimulus/context-control state effect, when we look at the interaction between cue (high/low) and congruency, as I stated above in c12.