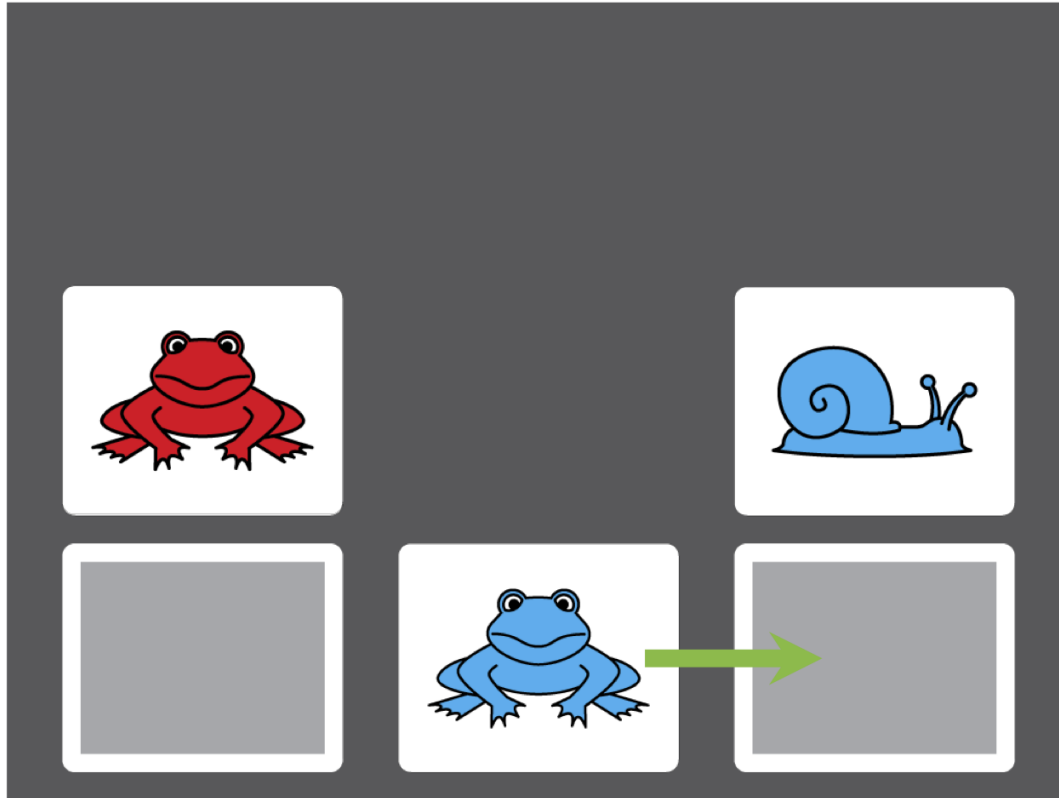


Dimensional Change Card Sort task

Binomial hidden Markov model

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DCCS: the task



DCCS mixture model: results

```
Mixture probabilities model
      pr1      pr2      pr3
0.1632349 0.1863544 0.6504107

Response parameters
Resp 1 : binomial
      Rel.(Intercept)
St1      -8.1494165
St2      -0.7929676
St3       2.8767057
```

$$\theta_1 = \frac{-8.149}{1 + \exp(-8.149)} = 0$$

$$\theta_2 = \frac{-0.793}{1 + \exp(-0.793)} = 0.312$$

$$\theta_3 = \frac{2.877}{1 + \exp(2.877)} = 0.947$$

Is the “guessing” state an artifact due to some people switching between the “switch” and “no-switch” state?

DCCS hidden Markov model

Do children learn or shift during the task?

- In the mixture model we assumed children did not learn during the task. The model assumed that all 6 items had an identical probability of being answered correctly.
- What if children suddenly see the light and start answering items correctly?

Instead of a mixture model we need a hidden Markov model!

DCCS hidden Markov model

Do children learn or shift during the task?

Hidden (or Latent) Markov model:

Treat the data as longitudinal, instead of taking the sum over 6 items

DCCS hidden Markov model

The `depmix()` function is similar to the `mix()` function, but takes an additional argument

1. `ntimes`: a vector with the length of each time-series in the data.

Note that for simplicity, we model the binary responses as a multinomial (with 2 levels) and an `identity` link function.

The estimated parameters are then equal to the probability of a correct response.

DCCS hidden Markov model

```
1 # restructure the data as longitudinal
2 dcl <- data.frame(acc=c(t(dccs[,8:13])))
3 head(dcl)
```

```
acc
1  1
2  1
3  1
4  1
5  1
6  1
```

DCCS hidden Markov model

```
1 # set up a hidden (or dependent) Markov model
2 hm2 <- depmix(acc~1,nstates=2,data=dcl,
3               ntimes=rep(6,93), family=multinomial("identity"))
4 set.seed(1234)
5 fhm2 <- fit(hm2)
```

converged at iteration 40 with logLik: -179.1912

```
1 fhm2
```

Convergence info: Log likelihood converged to within tol. (relative change)
'log Lik.' -179.1912 (df=5)
AIC: 368.3824
BIC: 390.0042

DCCS hidden Markov model: results

Initial state probabilities model

pr1	pr2
0.548	0.452

Transition matrix

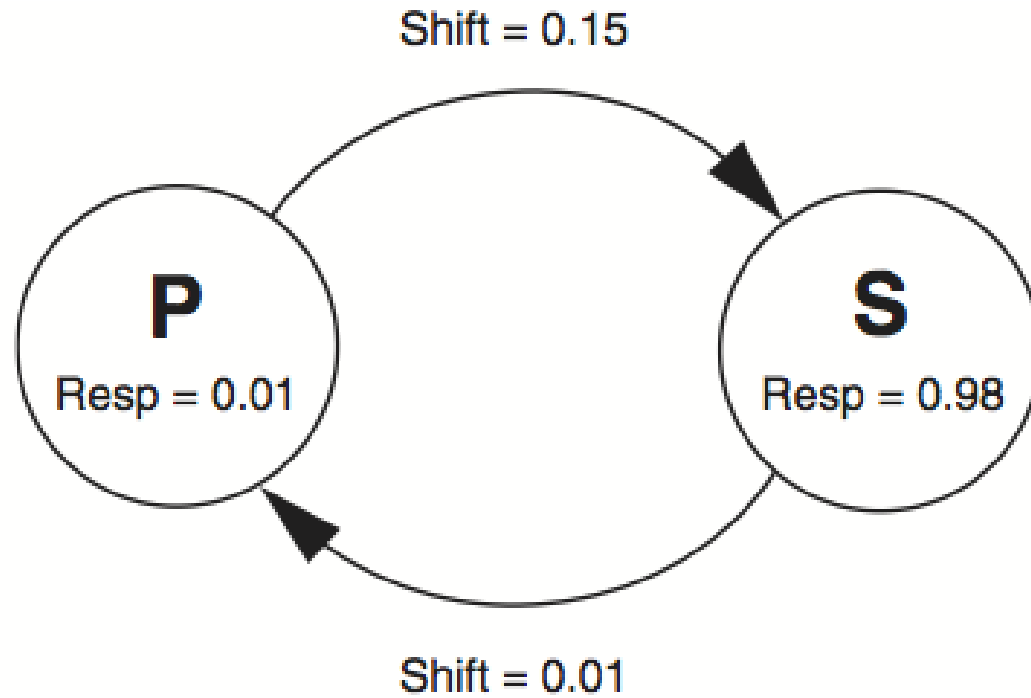
	toS1	toS2
fromS1	0.986	0.014
fromS2	0.158	0.842

Response parameters

Resp 1 : multinomial

	Re1.0	Re1.1
St1	0.013	0.987
St2	0.992	0.008

DCCS hidden Markov model: results



Did we account for the 'guessing' state?

nstates	AIC	BIC
1	706.68	711
2	368.38	390
3	371.71	419.28
4	380.07	462.24
5	399.04	524.44

