



Hearts & Flowers

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Contents

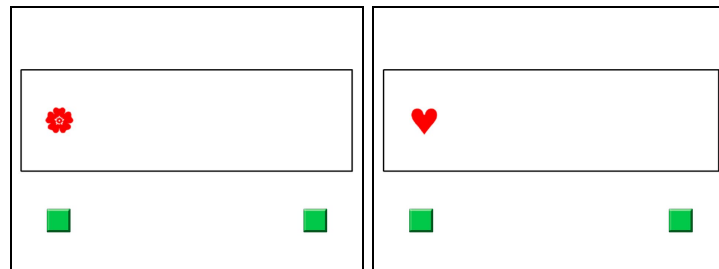
Task Description	2
Clean vs. Analysis Data Files	2
Scoring Procedures	3
Figure 1. Hearts and Flowers Settings Menu	4
Hearts and Flowers Variable Naming Guide	5
Table 1. Hearts and Flowers Settings	6
Table 2. Hearts and Flowers Trial Data	9
Table 3. Hearts and Flowers Analytic Variables	12

Task Description

This game measures **inhibitory control** and **cognitive flexibility**, two components of executive functions.

There are up to four blocks: hearts, flowers, mixed 1, and mixed 2.

In all four blocks, a red heart or flower appears on the right or left side of the screen.



1. **Congruent Trials:** In the hearts block, the child is instructed to touch a green square button on the same side as the heart.
2. **Incongruent Trials:** In the flowers block, the child is instructed to touch a green square button on the opposite side as the flower.
3. **Mixed Trials:** In the mixed blocks, the child is presented with a mix of hearts and flowers and needs to flexibly switch between the two rules (heart = same side; flower = opposite side).

Performance is measured using accuracy (proportion correct) and reaction time for the flowers block (inhibitory control) and mixed block(s) (cognitive flexibility).

Clean vs. Analysis Data Files

The clean data files include all cases, whereas the analysis data files exclude cases with incompatible settings.

Scoring Procedures

1. Anticipatory responses: If the participant responds in less than 200 ms, the trial is scored as missing for accuracy and reaction time.
2. Reaction time is set to missing for the first trial in each block.
3. Reaction time is only recorded for trials when the participant responds, and is set to missing for incorrect trials.
4. There are two versions of the accuracy scores. The “acc” variables only include trials with a response; non-responses are scored as missing. The “acc_to” variables include trials without a response, which are scored as incorrect. **The “acc_to” variables are recommended for analysis.**
5. Missing responses: If participants fail to respond for six or more consecutive trials, those trials are excluded from accuracy calculations. This only affects the “acc_to” variables.
6. Perseverative responding: If participants press the same button for ten or more consecutive trials, that sequence of responses is set to missing for accuracy and reaction time.
7. At least one third of the data for a variable must be non-missing to calculate the composite. The missing data rate for reaction time variables will always meet or exceed the missing data rate for accuracy variables.
8. If participants didn’t achieve a score of at least 50% (chance) for the hearts congruent “acc” variable, their scores for all other blocks were set to missing.

Figure 1. Hearts and Flowers Settings Menu

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Hearts and Flowers: Task Settings

<input checked="" type="checkbox"/> 1: Hearts	<input checked="" type="checkbox"/> 2: Flowers	<input checked="" type="checkbox"/> 3: Mixed	<input checked="" type="checkbox"/> 4: Mixed
# practice trials	# practice trials	# practice trials	
6	6	6	
# correct practice trials	# correct practice trials	# correct practice trials	
2	2	3	
# test trials	# test trials	# test trials	# test trials
8	12	12	12
Stimulus present time(ms)	Stimulus present time(ms)	Stimulus present time(ms)	Stimulus present time(ms)
1500	1500	1500	1250
Inter-stimulus interval(ms)	Inter-stimulus interval(ms)	Inter-stimulus interval(ms)	Inter-stimulus interval(ms)
500	500	500	500

[Home](#) [Back](#) [Edit](#)

Hearts and Flowers Variable Naming Guide

Hearts and Flowers variable names have three parts, each separated by an underscore.

Part 1: Game identifier

hf = hearts and flowers

Part 2: Block identifier

hp = hearts practice

ht = hearts test

fp = flowers practice

ft = flowers test

m1p = mixed 1 practice

m1t = mixed 1 test

m2t = mixed 2 test

Part 3: Measure identifier

See Tables 1-3 for details

Table 1. Hearts and Flowers Settings

Note: The settings variables are not included in the “trial” data files.

Variable Name	Label	Description
hf_hp_max	HF Hearts Practice: Maximum Number of Trials	Maximum number of practice trials in the hearts block. Data type: numeric Value range = 0-12
hf_hp_min	HF Hearts Practice: Minimum Number of Trials	Number of trials the participant must get correct in a row for the hearts practice block to end early. Data type: numeric Value range = 0-12
hf_ht_stim	HF Hearts Test: Stimulus Presentation Time	Amount of time (s) that the stimulus is presented in the hearts test block. Data type: numeric Value range = .5-3 s
hf_ht_isi	HF Hearts Test: Inter-Stimulus Interval	Amount of time (s) between each trial in the hearts test block. Data type: numeric Value range = 0-1 s
hf_ht_n	HF Hearts Test: Number of Trials	Number of trials in the hearts test block. Data type: numeric Value range = 8-32
hf_fp_max	HF Flowers Practice: Maximum Number of Trials	Maximum number of practice trials in the flowers block. Data type: numeric

		Value range = 0-12
hf_fp_min	HF Flowers Practice: Minimum Number of Trials	Number of trials the participant must get correct in a row for the flowers practice block to end early. Data type: numeric Value range = 0-12
hf_ft_stim	HF Flowers Test: Stimulus Presentation Time	Amount of time (s) that the stimulus is presented in the flowers test block. Data type: numeric Value range = .5-3 s
hf_ft_isi	HF Flowers Test: Inter-Stimulus Interval	Amount of time (s) between each trial in the flowers test block. Data type: numeric Value range = 0-1 s
hf_ft_n	HF Flowers Test: Number of Trials	Number of trials in the flowers test block. Data type: numeric Value range = 8-32
hf_m1p_max	HF Mixed 1 Practice: Maximum Number of Trials	Maximum number of practice trials in the hearts block. Data type: numeric Value range = 0-12
hf_m1p_min	HF Mixed 1 Practice: Minimum Number of Trials	Number of trials the participant must get correct in a row for the hearts practice block to end early. Data type: numeric Value range = 0-12

hf_m1t_stim	HF Mixed 1 Test: Stimulus Presentation Time	Amount of time (s) that the stimulus is presented in the hearts test block. Data type: numeric Value range = .5-3 s
hf_m1t_isi	HF Mixed 1 Test: Inter-Stimulus Interval	Amount of time (s) between each trial in the first mixed test block. Data type: numeric Value range = 0-1 s
hf_m1t_n	HF Mixed 1 Test: Number of Trials	Number of trials in the first mixed test block. Data type: numeric Value range = 8-32
hf_m2t_stim	HF Mixed 2 Test: Stimulus Presentation Time	Amount of time (s) that the stimulus is presented in the second mixed test block. Data type: numeric Value range = .5-3 s
hf_m2t_isi	HF Mixed 2 Test: Inter-Stimulus Interval	Amount of time (s) between each trial in the second mixed test block. Data type: numeric Value range = 0-1 s
hf_m2t_n	HF Mixed 2 Test: Number of Trials	Number of trials in the second mixed test block. Data type: numeric Value range = 8-32

Table 2. Hearts and Flowers Trial Data

Variable Name	Label	Description
id	AMES Participant Identifier	Six-digit child ID variable. Data type: character
block	HF Block	There are up to seven blocks of trials. Note that there is no practice round for Mixed Block 2. Data type: factor (7 levels) 1 = hp (Hearts Practice) 2 = ht (Hearts Trial) 3 = fp (Flowers Practice) 4 = ft (Flowers Trial) 5 = m1p (Mixed Block 1 Practice) 6 = m1t (Mixed Block 1 Trial) 7 = m2t (Mixed Block 2 Trial)
n	HF Trial Number	Trial number Data type: integer range: 1-32
stim_shape	HF Stimulus Shape	Data type: factor (2 levels) 1 = Heart 2 = Flower
stim_side	HF Stimulus Side	Data type: factor (2 levels) 1 = Right 2 = Left
resp_side	HF Response Side	Data type: factor (2 levels) 1 = Right 2 = Left
acc	HF Accuracy (Timed Out = Missing)	Is the response correct? Timed-out trials are counted as missing. Data type: logical Note: If FALSE, reaction time is scored as missing (NA).

acc_to	HF Accuracy (Timed Out = Incorrect)	Is the response correct? Timed-out trials are counted as incorrect. Data type: logical
rt	HF Reaction Time (Correct Trials)	Amount of time (s) between the stimulus presentation and the participant's response. Recorded only for correct trials. Data type: numeric
rt_all	HF Reaction Time (Correct and Incorrect Trials)	Amount of time (s) between the stimulus presentation and the participant's response. Recorded for all trials. Data type: numeric
to	HF Timed Out	Did the participant fail to respond in time? Data type: logical
ar	HF Anticipatory Response	Did the participant respond in less than 200 ms? It is physically impossible to respond without guessing in such a short amount of time. Data type: logical Note: When this is TRUE, accuracy and reaction time are both scored as missing (NA).
sw	HF Type of Switch	Switching is relative to the previous trial and is missing for the first trial. Data type: factor (4 levels) 1 = None 2 = Side 3 = Shape 4 = Both
streak	HF Number of Consecutive Trials with the Same Response	This is used to identify perseverative responding and to exclude these trials. Data type: integer

streak_na	HF Number of Consecutive Trials with No Response	This is used to exclude sequences of trials without any responses. Data type: integer
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Table 3. Hearts and Flowers Analytic Variables

Variable Name	Label	Description
id	AMES Participant Identifier	Six-digit child ID variable. Data type: character
hf_hp_start	HF Hearts Practice: Block Start Time	Data type: POSIXct (i.e., the number of seconds since the start of January 1, 1970)
hf_hp_end	HF Hearts Practice: Block End Time	Data type: POSIXct
hf_ht_start	HF Hearts Test: Block Start Time	Data type: POSIXct
hf_ht_end	HF Hearts Test: Block End Time	Data type: POSIXct
hf_fp_start	HF Flowers Practice: Block Start Time	Data type: POSIXct
hf_fp_end	HF Flowers Practice: Block End Time	Data type: POSIXct
hf_ft_start	HF Flowers Test: Block Start Time	Data type: POSIXct
hf_ft_end	HF Flowers Test: Block End Time	Data type: POSIXct
hf_m1p_start	HF Mixed 1 Practice: Block Start Time	Data type: POSIXct
hf_m1p_end	HF Mixed 1 Practice: Block End Time	Data type: POSIXct

hf_m1t_start	HF Mixed 1 Test: Block Start Time	Data type: POSIXct
hf_m1t_end	HF Mixed 1 Test: Block End Time	Data type: POSIXct
hf_m2t_start	HF Mixed 2 Test: Block Start Time	Data type: POSIXct
hf_m2t_end	HF Mixed 2 Test: Block End Time	Data type: POSIXct
hf_hp_n	HF Hearts Practice: Number of Trials	Number of trials in the hearts practice block. Data type: integer
hf_hp_acc	HF Hearts Practice: Accuracy	Proportion of correct trials in the hearts practice block. Data type: numeric
hf_ht_acc	HF Hearts Test: Accuracy (Timed Out = Missing)	Proportion of correct trials in the hearts test block. Timed-out trials are counted as <u>missing</u> . Data type: numeric
hf_ht_acc_to	HF Hearts Test: Accuracy (Timed Out = Incorrect)	Proportion of correct trials in the hearts test block. Timed-out trials are counted as <u>incorrect</u> . Data type: numeric
hf_ht_rt	HF Hearts Test: Reaction Time	Amount of time (s) between the stimulus presentation and the participant's response in the hearts test block. <u>Recorded only for correct trials</u> . Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer).

		Data type: numeric
hf_ht_iiv	HF Hearts Test: Reaction Time Intra-Individual Variability	<p>Standard deviation of the child's reaction times for each correct trial in the hearts test block in the hearts test block.</p> <p>Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer).</p> <p>Data type: numeric</p>
hf_ht_ar	HF Hearts Test: Anticipatory Response	<p>Proportion of anticipatory responses (< 200 ms) in the hearts test block.</p> <p>Data type: numeric</p>
hf_ht_to	HF Hearts Test: Timed Out	<p>Proportion of timed out trials in the hearts test block.</p> <p>Data type: numeric</p>
hf_fp_n	HF Flowers Practice: Number of Trials	<p>Number of trials in the flowers practice block.</p> <p>Data type: integer</p>
hf_fp_acc	HF Flowers Practice: Accuracy	<p>Proportion of correct trials in the flowers practice block.</p> <p>Data type: numeric</p>
hf_ft_acc	HF Flowers Test: Accuracy (Timed Out = Missing)	<p>Proportion of correct trials in the flowers test block. Timed-out trials are counted as <u>missing</u>.</p> <p>Data type: numeric</p>
hf_ft_acc_to	HF Flowers Test: Accuracy (Timed Out = Incorrect)	<p>Proportion of correct trials in the flowers test block. Timed-out trials are counted as <u>incorrect</u>.</p> <p>Data type: numeric</p>
hf_ft_rt	HF Flowers Test: Reaction Time	Amount of time (s) between the stimulus presentation and the participant's response in

		<p>the flowers test block. <u>Recorded only for correct trials.</u></p> <p>Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer).</p> <p>Data type: numeric</p>
hf_ft_iiv	HF Flowers Test: Reaction Time Intra-Individual Variability	<p>Standard deviation of the child's reaction times for each correct trial in the flowers test block.</p> <p>Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer).</p> <p>Data type: numeric</p>
hf_ft_ar	HF Flowers Test: Anticipatory Response	<p>Proportion of anticipatory responses (< 200 ms) in the flowers test block.</p> <p>Data type: numeric</p>
hf_ft_to	HF Flowers Test: Timed Out	<p>Proportion of timed out trials in the flowers test block.</p> <p>Data type: numeric</p>
hf_m1p_n	HF Mixed 1 Practice: Number of Trials	<p>Number of trials in the hearts first mixed practice block.</p> <p>Data type: integer</p>
hf_m1p_acc	HF Mixed 1 Practice: Accuracy	<p>Proportion of correct trials in the first mixed practice block.</p> <p>Data type: numeric</p>
hf_m1t_acc	HF Mixed 1 Test: Accuracy (Timed Out = Missing)	<p>Proportion of correct trials in the first mixed test block. Timed-out trials are counted as <u>missing</u>.</p>

		Data type: numeric
hf_m1t_acc_to	HF Mixed 1 Test: Accuracy (Timed Out = Incorrect)	Proportion of correct trials in the first mixed test block. Timed-out trials are counted as <u>incorrect</u> . Data type: numeric
hf_m1t_rt	HF Mixed 1 Test: Reaction Time	Amount of time (s) between the stimulus presentation and the participant's response in the first mixed test block. <u>Recorded only for correct trials</u> . Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer). Data type: numeric
hf_m1t_iiv	HF Mixed 1 Test: Reaction Time Intra-Individual Variability	Standard deviation of the child's reaction times for each correct trial in the first mixed test block. Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer). Data type: numeric
hf_m1t_ar	HF Mixed 1 Test: Anticipatory Response	Proportion of anticipatory responses (< 200 ms) in the first mixed test block. Data type: numeric
hf_m1t_to	HF Mixed 1 Test: Timed Out	Proportion of timed out trials in the first mixed test block. Data type: numeric

hf_m2t_acc	HF Mixed 2 Test: Accuracy (Timed Out = Missing)	Proportion of correct trials in the second mixed test block. Timed-out trials are counted as <u>missing</u> . Data type: numeric
hf_m2t_acc_to	HF Mixed 2 Test: Accuracy (Timed Out = Incorrect)	Proportion of correct trials in the second mixed test block. Timed-out trials are counted as <u>incorrect</u> . Data type: numeric
hf_m2t_rt	HF Mixed 2 Test: Reaction Time	Amount of time (s) between the stimulus presentation and the participant's response in the second mixed test block. <u>Recorded only for correct trials</u> . Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer). Data type: numeric
hf_m2t_iiv	HF Mixed 2 Test: Reaction Time Intra-Individual Variability	Standard deviation of the child's reaction times for each correct trial in the second mixed test block. Only calculated if there are non-missing values for one-third of the trials in the block (rounded up to the nearest integer). Data type: numeric
hf_m2t_ar	HF Hearts Test: Anticipatory Response	Proportion of anticipatory responses (< 200 ms) in the second mixed test block. Data type: numeric
hf_m2t_to	HF Hearts Test: Timed Out	Proportion of timed out trials in the second mixed test block. Data type: numeric

hf_date	HF File Save Date/Time	Data type: POSIXct
hf_h_filter	HF Hearts: Settings Filter Variable	<p>Each unique combination of setting variables is assigned a number, starting with 1. The categories are ordered by a decreasing number of participants (e.g., 1 corresponds to the most prevalent combination of settings). This makes it easy to determine which participants share the same settings.</p> <p>Data type: integer</p>
hf_f_filter	HF Flowers: Settings Filter Variable	<i>See above.</i>
hf_m1_filter	HF Mixed 1: Settings Filter Variable	<i>See above.</i>
hf_m2_filter	HF Mixed 2: Settings Filter Variable	<i>See above.</i>