Online appendix for
Identifying discrete behavioural types: A re-analysis of public goods game contributions by hierarchical clustering

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A Comparison of typologies by study

In Table 1 we present a contingency table for each study, detailing the joint distribution of type assignments generated by the typologies T^F and T^H for the participants in the subsample from that study.

B Details on clustering calculations

In this section we report the results from the two-stage procedure that lead to the recommendation of five clusters. The first stage is based on the Duda-Hart criterion (Duda and Hart, 1973), and identifies a range of candidate values for the number of clusters C.

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	13	0	1	2	1	**17**
	SCC	0	4	9	0	0	**13**
	WCC	0	0	5	3	0	**8**
	UCH	0	0	1	0	0	**1**
	VAR	0	0	2	1	2	**5**
	Total	**13**	**4**	**18**	**6**	**3**	**44**

(a) Fischbacher et al. (2001)

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	10	0	2	0	5	**17**
	SCC	0	5	51	1	1	**58**
	WCC	0	0	14	8	9	**31**
	UCH	0	0	3	0	6	**9**
	VAR	0	0	9	1	35	**45**
	Total	**10**	**5**	**79**	**10**	**56**	**160**

(b) Herrmann and Thöni (2009)

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	32	0	4	9	10	**55**
	SCC	0	13	35	3	0	**51**
	WCC	0	0	18	5	1	**24**
	UCH	0	0	1	0	4	**5**
	VAR	0	0	0	0	5	**5**
	Total	**32**	**13**	**58**	**17**	**20**	**140**

(c) Fischbacher and Gächter (2010)

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	20	0	6	6	5	**37**
	SCC	0	15	51	2	0	**68**
	WCC	0	0	20	1	4	**25**
	UCH	0	0	1	0	4	**5**
	VAR	0	0	1	0	0	**1**
	Total	**20**	**15**	**79**	**9**	**13**	**136**

(d) Fischbacher et al. (2012)

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	2	0	0	2	0	**4**
	SCC	0	4	10	0	0	**14**
	WCC	0	0	8	1	0	**9**
	UCH	0	0	1	0	0	**1**
	VAR	0	0	0	0	3	**3**
	Total	**2**	**4**	**19**	**1**	**5**	**31**

(e) Cartwright and Lovett (2014)

		In T^F					
			CC				
		FR	XC	IC	HS	OT	**Total**
In $T^H(5)$	OWN	9	0	0	2	1	**12**
	SCC	0	2	7	1	0	**10**
	WCC	0	0	2	3	2	**7**
	UCH	0	0	3	0	2	**5**
	VAR	0	0	1	0	5	**6**
	Total	**9**	**2**	**13**	**6**	**10**	**40**

(f) Préget et al. (2016)

Table 1: Distributions of types as identified by typologies T^F and $T^H(5)$. The distribution is reported separately for the subsample drawn from each study surveyed.

	Duda and Hart		Silhouette
C	$\mathrm{Je}(2)/\mathrm{Je}(1)$	PT^2	index
1	0.4921	566.54	
2	0.7351	109.17	
3	0.5332	213.60	
4	0.6790	42.08	0.399
5	0.7930	55.35	0.424
6	0.7354	25.55	0.374
7	0.8448	11.57	0.372
8	0.8061	24.53	0.378
9	0.8203	30.66	0.364
10	0.7993	34.90	0.339

Table 2: Duda-Hart criterion and silhouette index for candidate numbers of clusters.

The Je(2)/Je(1) index and pseudo T-squared improve markedly in moving from 3 to 4 clusters, ruling out solutions with fewer than 4 clusters. Solutions with 4 to 10 clusters have similar results for the two measures with no clear trend. In the second stage, we turn to the mean silhouette index. This is maximised with five clusters. We select the five-cluster solution $T^H(5)$ as the recommended typology.

C Parameterised heuristic version of $T^H(4)$ and $T^H(5)$

The typologies $T^H(4)$ and $T^H(5)$ produced by hierarchical clustering suggests an organisation of participants into five groups. However, unlike T^F, which provides a heuristic that deterministically classifies any given Stage 2 contribution strategy, type identifications generated by hierarchical clustering are inherently relative. In the main body, we used the qualitative structure of the resulting clusters to propose a parameterised heuristic in the style of T^F; here we provide further supporting details.

We start with the observation that the two Stage 2 strategies which appear most frequently are (1) matching contributions exactly one-for-one, which is the core of the SCC cluster, and (2) contributing exactly zero in all contingencies, which is the core of the OWN cluster. So we begin by assigning exact one-for-one matchers to SCC. We then ask, for each other participant, how far away is their Stage 2 strategy from the exact one-for-one stereotype, using the Manhattan distance. The dotplot in Figure 1 summarises the distribution of these distances for each cluster generated in our data. All Stage 2 strategies with a distance of less than 62 are assigned to SCC. Therefore we

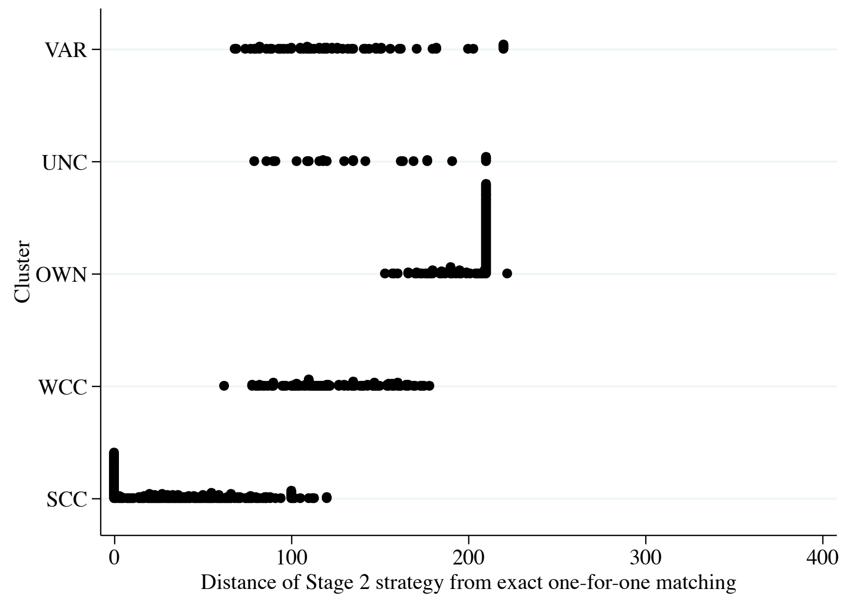

Figure 1: Distance from exact one-for-one matching of contributions, grouped by cluster. Each dot represents one participant.

have:

Step 1: All Stage 2 strategies with a distance of no more than 61 from exact one-for-one matching are considered SCC:

$$\text{SCC} = \left\{ (i, c^i) : \sum_{g=0}^{G} \left| c_g^i - g \right| \leq 61 \right\} \tag{1}$$

Next we turn to OWN. We ask, for each other participant, how far away is their Stage 2 strategy from the exact free-riding strategy of contributing zero in all contingencies. The dotplot in Figure 2 summarises the distribution of these distances for each cluster. All Stage 2 strategies with distances less than 32 from the exact free-riding stereotype are assigned to OWN. Therefore we have:

Step 2: All Stage 2 strategies with a distance of no more than 31 from exact free-riding, are considered OWN:

$$\text{OWN} = \left\{ (i, c^i) : \sum_{g=0}^{G} \left| c_g^i - 0 \right| \leq 31 \right\} \tag{2}$$

We remark that for the parameters proposed here, no Stage 2 strategy could be classified as both SCC and OWN. While the values of the tolerances can be adjusted, it would seem desirable to ensure the tolerances are not set so liberally as to allow overlap.

The third stereotypical rule that a Stage 2 strategy could follow is full contribution in all con-

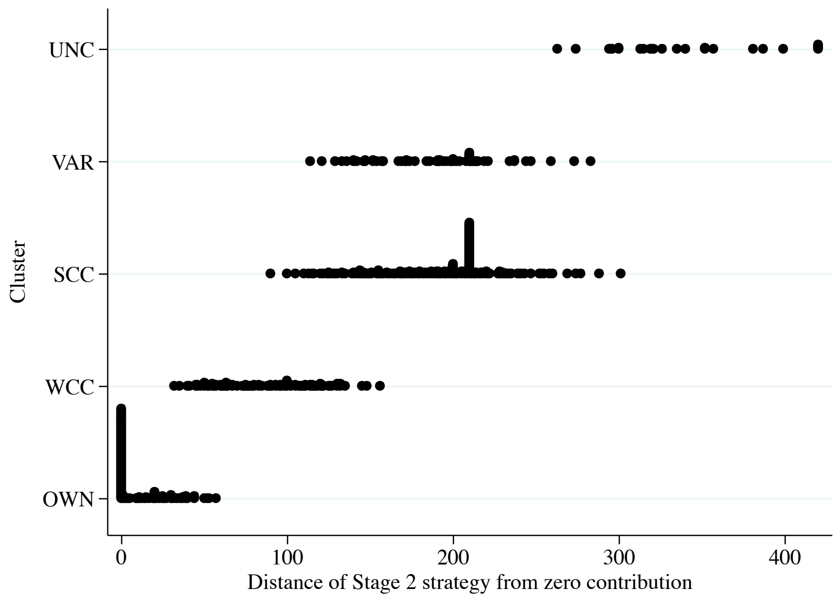

Figure 2: Distance from zero contributions in all contingencies, grouped by cluster. Each dot represents one participant.

tingencies, as this is the response that maximises group earnings conditional on the contingency. The dotplot in Figure 3 summarises the distribution of these distances for each cluster. All Stage 2 strategies with distances less than 119 from the exact full-contribution stereotype are assigned to UCH. Therefore we have:

Step 3: All Stage 2 strategies with a distance of no more than 118 from full contribution, are considered UCH.

$$\text{UCH} = \left\{ (i, c^i) : \sum_{g=0}^{G} \left| c_g^i - 20 \right| \leq 118 \right\} \tag{3}$$

Finally, neither WCC nor VAR have a single stereotypical strategy. However, in general, WCC contains Stage 2 strategies which match at a rate less than one-for-one, while VAR contains Stage 2 strategies which cross the one-for-one separatrix. To quantify this we compute a "generosity index" $\gamma(c^i)$ for each Stage 2 strategy, as the number of contingencies in which it prescribes a contribution above the one-for-one separatrix,

$$\gamma(c^i) = |\left\{ g : c_g^i > g \right\}| + \frac{1}{2} |\left\{ g : c_g^i = g \right\}|, \tag{4}$$

where we give one-half weight to contingencies in which exact one-for-one matching is prescribed. Almost all Stage 2 strategies c^i not yet assigned to SCC or OWN with $\gamma(c^1) \leq 5$ are classified as WCC. Therefore we have:

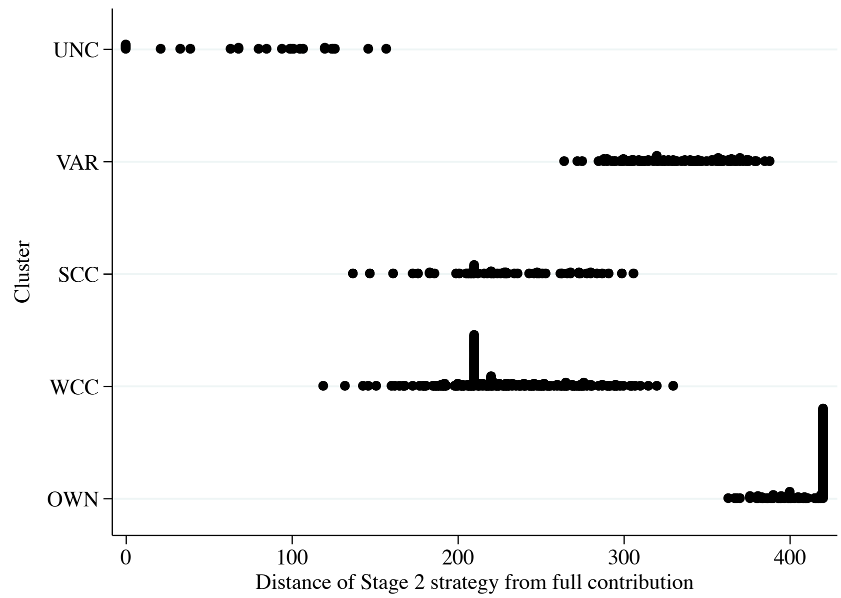

Figure 3: Distance from full contribution in all contingencies, grouped by cluster. Each dot represents one participant.

Step 4: All Stage 2 strategies c^i with $\gamma(c^i) \leq 5$ not yet assigned to another type are considered WCC:

$$\mathrm{WCC} = \left\{(i, c^i) \notin \mathrm{SCC} \cup \mathrm{OWN} \cup \mathrm{UCH} : \gamma(c^i) \leq 5\right\}. \tag{5}$$

D Comparison of clustering methods

As a robustness check, we conduct the clustering using k-means instead of Ward's linkage. Figure 5 displays the heatmaps of the clusters, with the clusters arising from Ward's linkage on the left and k-means on the right. The two methods generate very similar clusters; we therefore identify the k-means clusters using the same labels as for the Ward's linkage clusters.

Table 3 compares the classifications using the two approaches. The entries on the diagonal count the number of participants classified in the "same" cluster by both approaches. The main difference is in drawing the boundary around the weak conditional cooperators: there is a group of participants labeled WCC by Ward's linkage who are considered OWN by k-means, and another group labeled SCC by Ward's linkage but WCC by k-means.

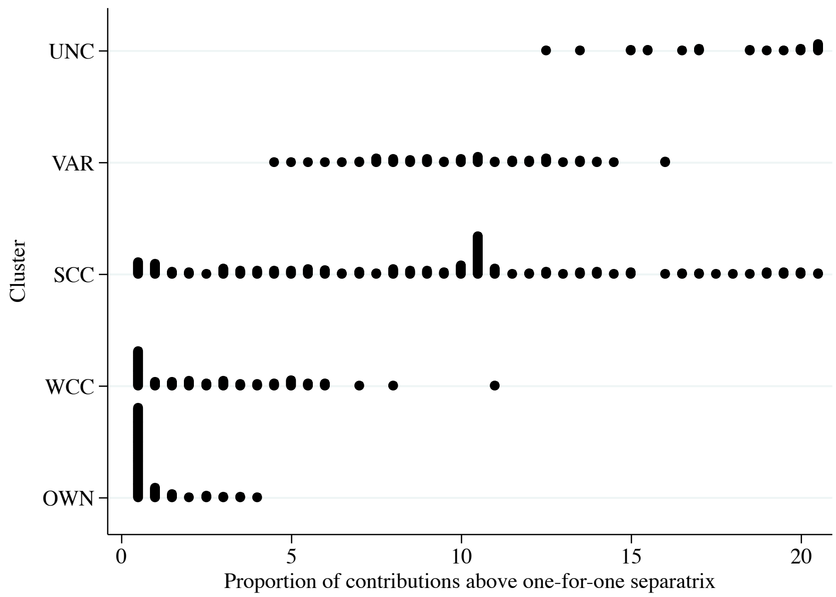

Figure 4: Number of contingencies in which Stage 2 strategy specifies a contribution above one-for-one matching, grouped by cluster. Each dot represents one participant.

		k-means					
		OWN	WCC	SCC	UCH	VAR	Total
$T^H(5)$	OWN	142	0	0	0	0	**142**
	WCC	41	62	1	0	0	**104**
	SCC	1	31	180	2	0	**214**
	UCH	0	0	0	26	0	**26**
	VAR	0	19	11	3	32	**65**
	Total	**184**	**112**	**192**	**31**	**32**	**551**

Table 3: Comparison of the $T^H(5)$ and k-means typologies. Each row corresponds to one type in the $T^H(5)$ typology, and each column to one type in the k-means typology. The cells report the number of participants overall to be classified in the row type in $T^H(5)$ and the column type in k-means.

$T^H(5)$ (Ward's linkage)	k-means

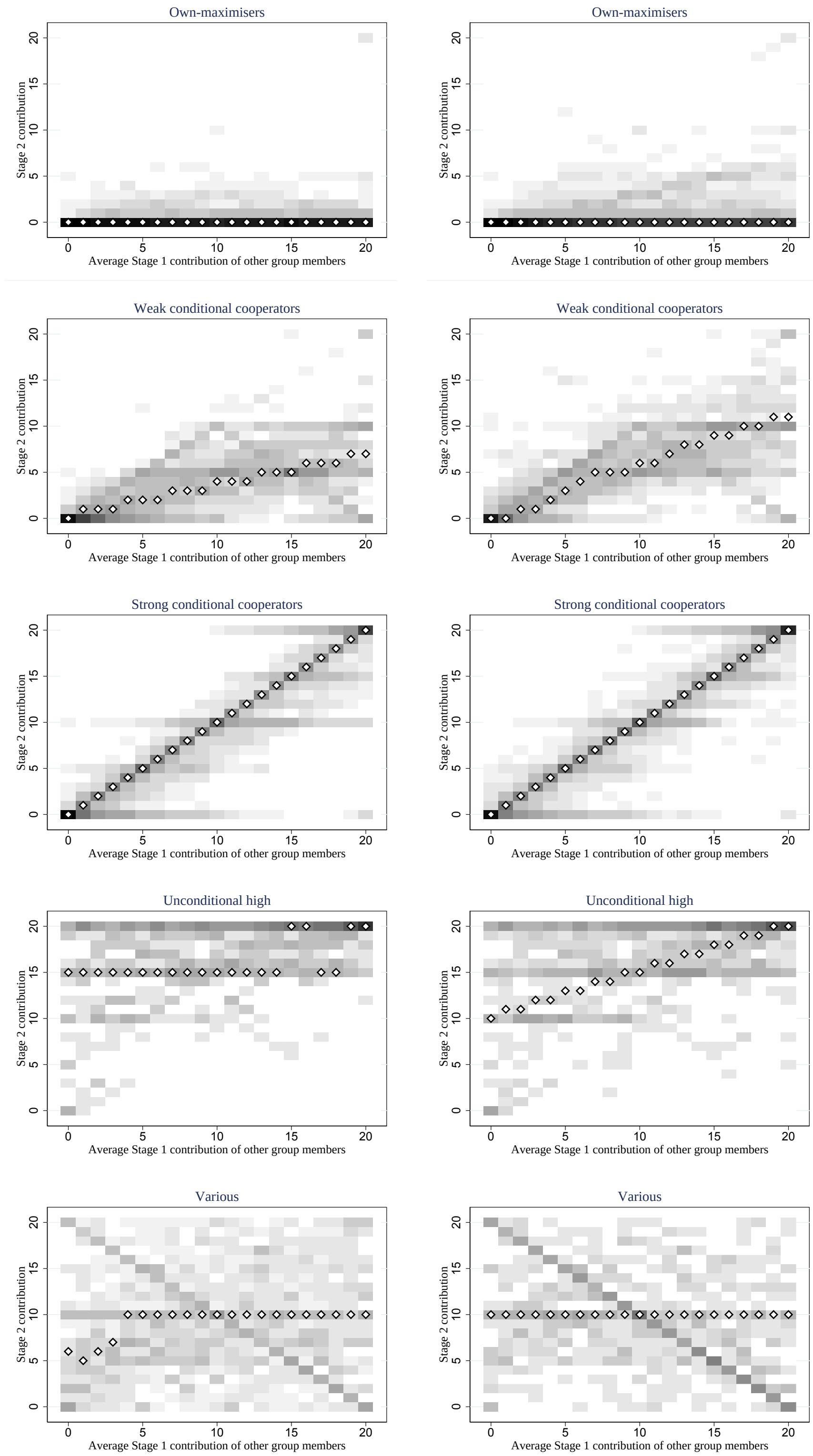

Figure 5: Clusters generated by Ward's linkage (left panels) and k-means (right panels).

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