

Societal utilities for cognitive impairment in Schizophrenia: Developing a preference-based scoring algorithm based on the Schizophrenia Cognition Rating Scale

Irene Santi, PhD¹; Andrew J. Lloyd, PhD²; Claudia E. Hastedt, PhD³, Matthijs M. Versteegh, PhD¹

¹ Institute for Medical Technology Assessment, Erasmus University, Rotterdam, The Netherlands

² Acaster Lloyd Consulting Ltd, London, United Kingdom

³ Boehringer Ingelheim International GmbH, Ingelheim am Rhein, Germany

Author ORCID numbers:

Irene Santi: 0000-0003-3812-2962

Andrew J. Lloyd: 0000-0002-7597-6556

Claudia E. Hastedt: 0000-0002-5748-5163

Matthijs M. Versteegh: 0000-0003-4804-235X

Corresponding Author

Irene Santi, PhD

Institute for Medical Technology Assessment, Erasmus University

Burgemeester Oudlaan 50

3062 PA, Rotterdam

The Netherlands

santi@imta.eur.nl

Phone: +31 10 408 1583

ORCID ID: 0000-0003-3812-2962

SUPPLEMENTARY MATERIAL

Appendix 1 – Vignettes of health states

Health state 1

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty understanding what people mean when they are talking to you
Mild
You have mild difficulty remembering information and/or instructions recently given to you (you rarely have difficulty remembering information)
Moderate
You have moderate difficulty staying focussed (frequently unable to stay focussed)
Moderate
You have moderate difficulty learning new things (takes longer and needs special attention)
Severe
You have severe difficulty speaking as fast as you would like (ability to converse is jeopardised because of cognitive difficulties)

Health state 2

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty learning new things
Mild
You have mild difficulty speaking as fast as you would like (rarely speak slowly because of cognitive difficulties)
Moderate
You have moderate difficulty understanding what people mean when they are talking to you (often have difficulty understanding what people mean)
Moderate
You have moderate difficulty staying focussed (frequently unable to stay focussed)
Severe
You have severe difficulty remembering information and/or instructions recently given to you (almost always forget information)

Health state 3

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty understanding what people mean when they are talking to you
Mild
You have mild difficulty speaking as fast as you would like (rarely speak slowly because of cognitive difficulties)
Mild
You have mild difficulty staying focussed (sometimes unable to stay focussed)
Moderate
You have moderate difficulty remembering information and/or instructions recently given to you (frequently forget information)
Severe
You have severe difficulty learning new things (unable to learn almost all new things)

Health state 4

Imagine that you have the following level of problems with memory and concentration

Severe You have severe difficulty staying focussed (almost always unable to stay focussed)
Severe You have severe difficulty learning new things (unable to learn almost all new things)
Severe You have severe difficulty speaking as fast as you would like (ability to converse is jeopardised because of cognitive difficulties)
Severe You have severe difficulty understanding what people mean when they are talking to you (frequently unable to understand what people mean)
Severe You have severe difficulty remembering information and/or instructions recently given to you (almost always forget information)

Health state 5

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty learning new things
None
You have no difficulty speaking as fast as you would like
None
You have no difficulty understanding what people mean when they are talking to you
None
You have no difficulty remembering information and/or instructions recently given to you
Severe
You have severe difficulty staying focussed (almost always unable to stay focussed)

Health state 6

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty staying focussed
None
You have no difficulty remembering information and/or instructions recently given to you
Mild
You have mild difficulty speaking as fast as you would like (rarely speak slowly because of cognitive difficulties)
Moderate
You have moderate difficulty learning new things (takes longer and needs special attention)
Severe
You have severe difficulty understanding what people mean when they are talking to you (frequently unable to understand what people mean)

Health state 7

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty speaking as fast as you would like
Mild
You have mild difficulty learning new things (takes longer to learn than most, but can usually do it)
Moderate
You have moderate difficulty staying focussed (frequently unable to stay focussed)
Moderate
You have moderate difficulty remembering information and/or instructions recently given to you (frequently forget information)
Severe
You have severe difficulty understanding what people mean when they are talking to you (frequently unable to understand what people mean)

Health state 8

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty staying focussed
None
You have no difficulty learning new things
Mild
You have mild difficulty understanding what people mean when they are talking to you (some difficulty understanding what people mean)
Moderate
You have moderate difficulty remembering information and/or instructions recently given to you (frequently forget information)
Severe
You have severe difficulty speaking as fast as you would like (ability to converse is jeopardised because of cognitive difficulties)

Health state 9

Imagine that you have the following level of problems with memory and concentration

Moderate
You have moderate difficulty learning new things (takes longer and needs special attention)
Moderate
You have moderate difficulty speaking as fast as you would like (often speaks slowly because of cognitive difficulties)
Moderate
You have moderate difficulty understanding what people mean when they are talking to you (often have difficulty understanding what people mean)
Moderate
You have moderate difficulty remembering information and/or instructions recently given to you (frequently forget information)
Severe
You have severe difficulty staying focussed (almost always unable to stay focussed)

Health state 10

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty speaking as fast as you would like
Mild
You have mild difficulty staying focussed (sometimes unable to stay focussed)
Mild
You have mild difficulty understanding what people mean when they are talking to you (some difficulty understanding what people mean)
Moderate
You have moderate difficulty learning new things (takes longer and needs special attention)
Severe
You have severe difficulty remembering information and/or instructions recently given to you (almost always forget information)

Health state 11

Imagine that you have the following level of problems with memory and concentration

Mild
You have mild difficulty learning new things (takes longer to learn than most, but can usually do it)
Mild
You have mild difficulty speaking as fast as you would like (rarely speak slowly because of cognitive difficulties)
Mild
You have mild difficulty understanding what people mean when they are talking to you (some difficulty understanding what people mean)
Mild
You have mild difficulty remembering information and/or instructions recently given to you (you rarely have difficulty remembering information)
Severe
You have severe difficulty staying focussed (almost always unable to stay focussed)

Health state 12

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty staying focussed
None
You have no difficulty speaking as fast as you would like
Mild
You have mild difficulty remembering information and/or instructions recently given to you (you rarely have difficulty remembering information)
Moderate
You have moderate difficulty understanding what people mean when they are talking to you (often have difficulty understanding what people mean)
Severe
You have severe difficulty learning new things (unable to learn almost all new things)

Health state 13

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty learning new things
Mild
You have mild difficulty staying focussed (sometimes unable to stay focussed)
Mild
You have mild difficulty remembering information and/or instructions recently given to you (you rarely have difficulty remembering information)
Moderate
You have moderate difficulty speaking as fast as you would like (often speaks slowly because of cognitive difficulties)
Severe
You have severe difficulty understanding what people mean when they are talking to you (frequently unable to understand what people mean)

Health state 14

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty remembering information and/or instructions recently given to you
Mild
You have mild difficulty staying focussed (sometimes unable to stay focussed)
Mild
You have mild difficulty learning new things (takes longer to learn than most, but can usually do it)
Moderate
You have moderate difficulty understanding what people mean when they are talking to you (often have difficulty understanding what people mean)
Severe
You have severe difficulty speaking as fast as you would like (ability to converse is jeopardised because of cognitive difficulties)

Health state 15

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty staying focussed
None
You have no difficulty understanding what people mean when they are talking to you
Mild
You have mild difficulty learning new things (takes longer to learn than most, but can usually do it)
Moderate
You have moderate difficulty speaking as fast as you would like (often speaks slowly because of cognitive difficulties)
Severe
You have severe difficulty remembering information and/or instructions recently given to you (almost always forget information)

Health state 16

Imagine that you have the following level of problems with memory and concentration

None
You have no difficulty remembering information and/or instructions recently given to you
Mild
You have mild difficulty understanding what people mean when they are talking to you (some difficulty understanding what people mean)
Moderate
You have moderate difficulty staying focussed (frequently unable to stay focussed)
Moderate
You have moderate difficulty speaking as fast as you would like (often speaks slowly because of cognitive difficulties)
Severe
You have severe difficulty learning new things (unable to learn almost all new things)

Table S1 Spearman's correlation Coefficients Between Interviewer SCoRS items and MCCB Domains – SCoRS items corresponding to the MCCB domains are highlighted in grey

	MCCB Cognitive Domain								
SCoRS Item	Speed of Processing Score	Attention/Vigilance Score	Working Memory Score	Verbal Learning Score	Visual Learning Score	Reasoning and Problem Solving Score	Social Cognition Score	Neuro-Cognitive Composite Score	Overall Composite Score
1.Remembering names of people you know or meet?	-0.11 (0.019)	-0.13 (0.004)	-0.09 (0.051)	-0.11 (0.012)	-0.06 (0.168)	0.01 (0.862)	-0.07 (0.130)	-0.12 (0.008)	-0.12 (0.008)
2.Remembering how to get places?	-0.12 (0.007)	-0.05 (0.246)	-0.11 (0.014)	-0.10 (0.020)	-0.13 (0.005)	-0.03 (0.501)	-0.11 (0.011)	-0.12 (0.005)	-0.14 (0.002)
3.Following a TV show?	-0.09 (0.037)	-0.04 (0.326)	-0.00 (0.938)	-0.04 (0.320)	-0.01 (0.903)	-0.02 (0.711)	-0.07 (0.106)	-0.05 (0.260)	-0.06 (0.176)
4.Remembering where you put things?	-0.08 (0.064)	-0.10 (0.026)	-0.12 (0.008)	-0.05 (0.224)	-0.13 (0.003)	-0.02 (0.709)	-0.03 (0.547)	-0.11 (0.011)	-0.11 (0.019)
5.Remembering your chores and responsibilities?	-0.09 (0.058)	-0.07 (0.118)	-0.09 (0.037)	-0.11 (0.010)	-0.10 (0.034)	0.06 (0.152)	-0.02 (0.645)	-0.08 (0.071)	-0.09 (0.058)
6.Learning how to use new gadgets and equipment?	-0.18 (<.001)	-0.14 (0.001)	-0.20 (<.001)	-0.13 (0.003)	-0.16 (<.001)	-0.13 (0.003)	-0.20 (<.001)	-0.21 (<.001)	-0.24 (<.001)
7.Remembering information and/or instructions recently given to you?	-0.13 (0.003)	-0.21 (<.001)	-0.14 (0.001)	-0.15 (<.001)	-0.09 (0.052)	-0.01 (0.873)	-0.09 (0.049)	-0.15 (<.001)	-0.16 (<.001)
8.Remembering what you were going to say?	-0.06 (0.162)	-0.08 (0.068)	-0.09 (0.049)	-0.08 (0.069)	-0.10 (0.030)	-0.00 (0.939)	0.01 (0.843)	-0.09 (0.039)	-0.08 (0.073)
9.Keeping track of your money?	-0.12 (0.010)	-0.09 (0.042)	-0.16 (<.001)	-0.10 (0.021)	-0.12 (0.006)	-0.05 (0.282)	-0.06 (0.167)	-0.14 (0.002)	-0.14 (0.002)
10.Keeping your words from being jumbled together?	-0.07 (0.148)	-0.08 (0.060)	-0.14 (0.002)	-0.09 (0.049)	-0.11 (0.017)	0.00 (0.947)	-0.14 (0.002)	-0.12 (0.009)	-0.14 (0.002)
11.Concentrating well enough to read a newspaper or a book?	-0.09 (0.058)	-0.05 (0.304)	-0.05 (0.233)	-0.08 (0.094)	-0.03 (0.540)	0.01 (0.840)	-0.14 (0.003)	-0.06 (0.184)	-0.08 (0.079)
12.With familiar tasks?	-0.03 (0.469)	-0.03 (0.548)	-0.06 (0.210)	-0.03 (0.462)	-0.06 (0.198)	0.03 (0.534)	-0.09 (0.050)	-0.04 (0.414)	-0.05 (0.305)

	MCCB Cognitive Domain								
SCoRS Item	Speed of Processing Score	Attention/Vigilance Score	Working Memory Score	Verbal Learning Score	Visual Learning Score	Reasoning and Problem Solving Score	Social Cognition Score	Neuro-Cognitive Composite Score	Overall Composite Score
13.Staying focused?	-0.13 (0.005)	-0.12 (0.007)	-0.08 (0.060)	-0.13 (0.004)	-0.12 (0.008)	-0.07 (0.133)	-0.10 (0.024)	-0.14 (0.001)	-0.15 (<.001)
14.Learning new things?	-0.19 (<.001)	-0.12 (0.010)	-0.16 (<.001)	-0.17 (<.001)	-0.16 (<.001)	-0.09 (0.048)	-0.17 (<.001)	-0.19 (<.001)	-0.21 (<.001)
15.Speaking as fast as you would like?	-0.18 (<.001)	-0.18 (<.001)	-0.14 (0.001)	-0.14 (0.002)	-0.07 (0.119)	-0.13 (0.004)	-0.06 (0.167)	-0.20 (<.001)	-0.19 (<.001)
16.Doing things quickly?	-0.14 (0.001)	-0.10 (0.028)	-0.12 (0.007)	-0.07 (0.098)	-0.08 (0.075)	-0.05 (0.282)	-0.08 (0.061)	-0.13 (0.004)	-0.13 (0.003)
17.Handling changes in your daily routine?	-0.06 (0.185)	-0.06 (0.191)	-0.09 (0.046)	-0.00 (0.967)	-0.07 (0.128)	-0.06 (0.219)	-0.02 (0.633)	-0.08 (0.061)	-0.09 (0.054)
18.Understanding what people mean when they are talking to you?	-0.08 (0.089)	-0.09 (0.057)	-0.15 (<.001)	-0.16 (<.001)	-0.19 (<.001)	-0.04 (0.355)	-0.19 (<.001)	-0.15 (<.001)	-0.18 (<.001)
19.Understanding how other people feel about things?	-0.03 (0.574)	-0.04 (0.327)	-0.10 (0.030)	-0.03 (0.479)	-0.15 (<.001)	-0.04 (0.351)	-0.11 (0.012)	-0.09 (0.052)	-0.10 (0.020)
20.Following conversations in a group?	-0.11 (0.012)	-0.05 (0.284)	-0.06 (0.168)	-0.09 (0.045)	-0.08 (0.084)	-0.08 (0.069)	-0.14 (0.002)	-0.11 (0.019)	-0.13 (0.005)

Table S2 Item parameter estimates from the graded response model (GRM) and corresponding standard errors (SE)

Domain	Item	β_{i1} (SE)	β_{i2} (SE)	β_{i3} (SE)	α (SE)
Memory	1.Remembering names of people you know or meet?	-0.799 (0.128)	1.789 (0.202)	4.364 (0.526)	1.067 (0.120)
Memory	2.Remembering how to get places?	0.682 (0.115)	2.448 (0.266)	5.926 (1.053)	1.162 (0.139)
Attention	3.Following a TV show?	-0.182 (0.108)	1.442 (0.179)	4.181 (0.505)	1.023 (0.119)
Memory	4.Remembering where you put things?	-0.743 (0.141)	1.317 (0.186)	3.739 (0.462)	0.897 (0.110)
Memory	5.Remembering your chores and responsibilities?	-0.367 (0.099)	1.266 (0.144)	3.710 (0.401)	1.239 (0.129)
Learning	6.Learning how to use new gadgets and equipment?	-0.409 (0.091)	0.925 (0.110)	3.357 (0.329)	1.444 (0.139)
Working memory	7.Remembering information and/or instructions recently given to you?	-1.038 (0.111)	0.716 (0.097)	3.009 (0.269)	1.541 (0.142)
Working memory	8.Remembering what you were going to say?	-0.736 (0.114)	1.484 (0.160)	4.806 (0.630)	1.217 (0.127)
Problem solving	9.Keeping track of your money?	0.170 (0.097)	1.635 (0.175)	3.297 (0.344)	1.175 (0.128)
Language	10.Keeping your words from being jumbled together?	0.210 (0.113)	2.382 (0.287)	5.495 (0.789)	0.962 (0.120)
Attention	11.Concentrating well enough to read a newspaper or a book?	-1.101 (0.123)	0.102 (0.088)	2.774 (0.258)	1.368 (0.133)
Problem solving	12.With familiar tasks?	0.934 (0.113)	2.276 (0.222)	5.103 (0.838)	1.425 (0.164)
Attention	13.Staying focused?	-1.094 (0.109)	0.659 (0.092)	3.289 (0.305)	1.652 (0.152)
Learning	14.Learning new things?	-0.654 (0.090)	0.864 (0.097)	3.039 (0.269)	1.732 (0.157)
Processing speed	15.Speaking as fast as you would like?	0.111 (0.104)	1.807 (0.216)	5.415 (0.779)	1.047 (0.126)

Processing speed	16.Doing things quickly?	0.039 (0.092)	1.560 (0.164)	3.654 (0.394)	1.267 (0.135)
Problem solving	17.Handling changes in your daily routine?	-0.113 (0.091)	1.518 (0.155)	4.142 (0.473)	1.323 (0.135)
Social Cognition	18.Understanding what people mean when they are talking to you?	-0.264 (0.091)	1.639 (0.158)	3.474 (0.352)	1.376 (0.137)
Social Cognition	19.Understanding how other people feel about things?	-0.249 (0.093)	1.103 (0.128)	3.240 (0.324)	1.304 (0.132)
Social Cognition	20.Following conversations in a group?	-0.613 (0.097)	0.782 (0.102)	2.422 (0.214)	1.441 (0.134)

Abbreviations: GRM graded response model; SE, standard error

Table S3 Study sample and UK general population characteristics

Socio-demographic characteristics	Study sample	UK population ¹
Age (years)		
n	399	
Mean (sd)	39.7 (15.2)	49.1 (18.1)
Median (Q1,Q3)	37.0 (27.0;50.0)	
Min;Max	18.0 ; 95.0	
Age group (years), n (%)	399	
18-40	233 (58.4)	34.7%
41-65	135 (33.8)	43.9%
65+	31 (7.8)	21.5%
Gender, n (%)	400	
Male	189 (47.3)	
Female	210 (52.5)	54.1%
Prefer not to answer	1 (0.3)	
Ethnicity, n (%)	400	
Prefer not to answer	2 (0.5)	
White	295 (73.8)	76.1%
Black	24 (6.0)	
Asian/British Asian	29 (7.3)	
Chinese/ Japanese/ Korean	5 (1.3)	
Other European	8 (2.0)	
Other	37 (9.3)	
Employment, n (%)	400	
Other	10 (2.5)	
Employed or self-employed, full-time	190 (47.5)	55.5%
Employed or self-employed, part-time	75 (18.8)	
Student	50 (12.5)	6.9%
Unemployed or seeking work	28 (7.0)	4.3%
Long term sick leave	1 (0.3)	
Stay at home/carer	8 (2.0)	
Retired	38 (9.5)	23.6%

¹ Understanding Society Wave 7 – UK panel of general population n≈40,000, 2015-17

Education, n (%)	400	
Other	8 (2.0)	
No formal qualifications	4 (1.0)	
Left school at age 16 with qualifications	36 (9.0)	
Left school at age 18 with qualifications	58 (14.5)	
Technical/ vocational qualifications from a college or job	66 (16.5)	24.2%
Completed university	228 (57.0)	23.5%
Income, n (%)	400	
<20K	78 (19.5)	
£20-£40K	89 (22.3)	
£40-£60K	70 (17.5)	
£60-£80K	53 (13.3)	
£80-£120K	44 (11.0)	
>£120K	16 (4.0)	
prefer not to answer	50 (12.5)	

Abbreviations: n, number; sd, standard deviation; Q1, 25th percentile; Q3, 75th percentile; min=minimum; max=maximum; K=thousand

Figure S1 Item information curves for the 20 SCoRS items

Table S4 Distribution of cTTO and VAS values by health state

		cTTO				VAS			
Health State*	N	Mean	SD	Median	Range	Mean	SD	Median	Range
11423	199	0.727	0.278	0.800	-1 – 1	58.86	17.07	60	0 - 90
12314	201	0.697	0.260	0.775	-1 – 0.975	55.35	16.15	60	10 - 90
13241	199	0.646	0.349	0.725	-1 – 0.975	53.89	16.45	55	0 - 85
14132	201	0.670	0.324	0.725	-1 – 0.975	55.24	15.97	55	7 - 87
21234	199	0.673	0.287	0.750	-1 – 0.975	51.92	16.38	50	6 - 90
21342	201	0.628	0.312	0.675	-1 – 0.975	51.58	16.51	50	3 - 90
22431	201	0.671	0.325	0.775	-1 – 0.975	54.67	16.21	55	5 - 87
23124	201	0.672	0.328	0.750	-1 – 1	53.33	16.14	55	5 - 90
24213	199	0.692	0.312	0.750	-1 – 0.975	52.72	16.40	55	10 - 90
32143	199	0.608	0.366	0.675	-1 – 0.975	49.68	16.99	50	0 - 85
33412	199	0.736	0.271	0.825	-1 – 1	57.42	17.29	60	5 - 95
34321	201	0.649	0.305	0.700	-1 – 1	50.86	17.15	50	10 – 100
41111	199	0.855	0.179	0.925	0.05 - 1	73.88	16.21	75	8 - 100
42222	201	0.743	0.318	0.825	-1 – 1	61.02	16.55	60	5 – 100
43333	201	0.575	0.353	0.65	-1 – 1	44.30	17.38	40	1 – 100
44444	199	0.152	0.575	0.275	-1 – 0.975	24.02	17.24	20	0 – 80
Overall	3200	0.650	0.359	0.725	-1 – 1	53.05	19.21	55	0 - 100

Abbreviations: cTTO, composite Time Trade-Off; VAS, Visual Analog Scale; N, number; SD, Standard deviation

*Each number corresponds to the level of the dimension, with the dimensions in the following order: Attention, Learning, Processing Speed, Social Cognition, Memory. For example, state 4444 in the table reflects the worst level on all dimensions, and 4111 would reflect no problems except for staying focused.

Table S5 Out of sample predictions – values in bold indicate predicted value within the confidence interval of the observe value

Health state	Observed		
	Mean	95% LCI	95% UCI
1	0.736	0.698	0.774
2	0.673	0.633	0.713
3	0.691	0.648	0.735
4	0.152	0.072	0.232
5	0.855	0.830	0.880
6	0.646	0.598	0.695
7	0.608	0.557	0.659
8	0.727	0.688	0.766
9	0.575	0.526	0.624
10	0.672	0.626	0.718
11	0.743	0.699	0.787
12	0.670	0.625	0.716
13	0.628	0.584	0.671
14	0.671	0.626	0.716
15	0.697	0.661	0.733
16	0.649	0.606	0.691

Abbreviations: LCI, lower confidence interval; UCI, upper confidence interval