

# Iterative Development of a Digital Dyadic CBT-I Program Adapted for Autistic School-Aged Children and Their Parents

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# Background

- ~ 80% of autistic children have insomnia
- Insomnia associated with
  - Decreased QOL
  - Increased stereotypic & challenging behaviors
  - Parental sleep disruption
  - Parental stress
- CBT-I promising for treating insomnia & its consequences
- Limited research on CBT-I in school-aged autistic children





RECHARGE

# CBT-I Tailored for Autistic School-Aged Children

#	CBT-I
1	Sleep Hygiene (SH) & Sleep Prescription
2	Bedtime Routine & Parent Management
3	Cue Control & Parent Management
4	Co-Sleeping & Parents Fading out of Room
5	Circadian Education, AM Routine, & Relaxation
6	Cognitive Therapy Basics
7	Nighttime Worries, Anxiety, & Nightmares
8	Wrap up

# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES</i> <sup>b</sup>	<i>t</i>	<i>p</i>	<i>ES</i> <sup>b</sup>
<i>Child Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	44.63	24.02	15.69	13.43	13.43	9.50	4.06	0.01*	1.41	4.76	0.00*	1.60
Total wake time (min)	61.75	42.85	17.09	12.13	14.90	9.43	3.82	0.01*	1.33	4.38	0.001*	1.41
Total sleep time (min)	515.09	65.30	577.73	28.00	573.69	24.49	−4.70	0.001*	1.17	−4.01	0.01*	1.11
Sleep efficiency (%) <sup>c</sup>	89.11	4.48	96.88	1.82	96.97	1.97	−5.35	0.00*	2.15	−5.32	0.00*	2.13
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	32.63	19.34	14.92	8.99	15.73	8.95	4.27	0.01*	1.07	4.13	0.01*	1.05
Total wake time (min)	106.42	23.49	72.20	28.54	77.19	30.74	10.56	0.00*	1.20	5.90	0.00*	0.98
Total sleep time (min)	506.98	50.93	545.72	26.74	544.10	33.25	−2.82	0.02	0.87	−4.12	0.01*	0.87
Sleep efficiency (%) <sup>c</sup>	80.37	4.35	85.81	2.49	84.78	3.26	−4.94	0.001*	1.22	3.64	0.01*	1.05
Bed/Waketime Regulation <sup>c,d</sup>												
Bedtime variability (min)	49.52	31.35	16.85	15.12	18.14	15.89	3.81	0.00*	1.24	4.35	0.00*	1.18
Waketime variability (min)	44.10	17.23	14.23	10.11	10.23	7.10	6.03	0.00*	1.98	9.15	0.00*	2.41
Daytime functioning – Aberrant Behavior Checklist												
Irritability	16.23	7.29	9.52	7.87	9.46	7.48	3.74	0.00*	0.83	3.78	0.00*	0.85
Lethargy	8.63	8.79	3.73	7.23	3.72	7.41	3.66	0.00*	0.56	3.69	0.00*	0.55
Stereotypy	2.74	1.21	1.01	1.28	1.03	0.49	4.05	0.00*	1.30	4.96	0.00*	1.73
Hyperactivity	19.53	11.49	14.72	10.16	14.87	9.23	3.63	0.001*	0.42	3.26	0.01	0.42
Inappropriate speech	5.23	2.78	3.37	2.23	3.14	2.18	3.12	0.01	0.69	3.95	0.00*	0.78

# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES</i> <sup>b</sup>	<i>t</i>	<i>p</i>	<i>ES</i> <sup>b</sup>
<i>Child Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	44.63	24.02	15.69	13.43	13.43	9.50	4.06	0.01*	1.41	4.76	0.00*	1.60
Total wake time (min)	61.75	42.85	17.09	12.13	14.90	9.43	3.82	0.01*	1.33	4.38	0.001*	1.41
Total sleep time (min)	515.09	65.30	577.73	28.00	573.69	24.49	-4.70	0.001*	1.17	-4.01	0.01*	1.11
Sleep efficiency (%) <sup>c</sup>	89.11	4.48	96.88	1.82	96.97	1.97	-5.35	0.00*	2.15	-5.32	0.00*	2.13
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	32.63	19.34	14.92	8.99	15.73	8.95	4.2	0.01*	1.07	4.13	0.01*	1.05
Total wake time (min)	106.42	23.49	72.20	28.54	77.19	30.74	10.55	0.00*	1.20	5.90	0.00*	0.98
Total sleep time (min)	506.98	50.93	545.72	26.74	544.10	33.25	-2.82	0.02	0.87	-4.12	0.01*	0.87
Sleep efficiency (%) <sup>c</sup>	80.37	4.35	85.81	2.49	84.78	3.26	-4.94	0.001*	1.22	3.64	0.01*	1.05
Bed/Waketime Regulation <sup>c,d</sup>												
Bedtime variability (min)	49.52	31.35	16.85	15.12	18.14	15.89	3.81	0.00*	1.24	4.35	0.00*	1.18
Waketime variability (min)	44.10	17.23	14.23	10.11	10.23	7.10	6.0	0.00*	1.98	9.15	0.00*	2.41
Daytime functioning – Aberrant Behavior Checklist												
Irritability	16.23	7.29	9.52	7.87	9.46	7.48	3.74	0.00*	0.83	3.78	0.00*	0.85
Lethargy	8.63	8.79	3.73	7.23	3.72	7.41	3.66	0.00*	0.56	3.69	0.00*	0.55
Stereotypy	2.74	1.21	1.01	1.28	1.03	0.49	4.05	0.00*	1.30	4.96	0.00*	1.73
Hyperactivity	19.53	11.49	14.72	10.16	14.87	9.23	3.63	0.001*	0.42	3.26	0.01	0.42
Inappropriate speech	5.23	2.78	3.37	2.23	3.14	2.18	3.12	0.01	0.69	3.95	0.00*	0.78

# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES</i> <sup>b</sup>	<i>t</i>	<i>p</i>	<i>ES</i> <sup>b</sup>
<i>Child Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	44.63	24.02	15.69	13.43	13.43	9.50	4.06	0.01*	1.41	4.76	0.00*	1.60
Total wake time (min)	61.75	42.85	17.09	12.13	14.90	9.43	3.82	0.01*	1.33	4.38	0.001*	1.41
Total sleep time (min)	515.09	65.30	577.73	28.00	573.69	24.49	-4.70	0.001*	1.17	-4.01	0.01*	1.11
Sleep efficiency (%) <sup>c</sup>	89.11	4.48	96.88	1.82	96.97	1.97	-5.35	0.00*	2.15	-5.32	0.00*	2.13
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	32.63	19.34	14.92	8.99	15.73	8.95	4.27	0.01*	1.07	4.13	0.01*	1.05
Total wake time (min)	106.42	23.49	72.20	28.54	77.19	30.74	10.56	0.00*	1.20	5.90	0.00*	0.98
Total sleep time (min)	506.98	50.93	545.72	26.74	544.10	33.25	-2.82	0.02	0.87	-4.12	0.01*	0.87
Sleep efficiency (%) <sup>c</sup>	80.37	4.35	85.81	2.49	84.78	3.26	-4.94	0.001*	1.22	3.64	0.01*	1.05
Bed/Waketime Regulation <sup>c,d</sup>												
Bedtime variability (min)	49.52	31.35	16.85	15.12	18.14	15.89	3.81	0.00*	1.24	4.35	0.00*	1.18
Waketime variability (min)	44.10	17.23	14.23	10.11	10.23	7.10	6.03	0.00*	1.98	9.15	0.00*	2.41
Daytime functioning – Aberrant Behavior Checklist												
Irritability	16.23	7.29	9.52	7.87	9.46	7.48	3.74	0.00*	0.83	3.78	0.00*	0.85
Lethargy	8.63	8.79	3.73	7.23	3.72	7.41	3.66	0.00*	0.56	3.69	0.00*	0.55
Stereotypy	2.74	1.21	1.01	1.28	1.03	0.49	4.05	0.00*	1.30	4.96	0.00*	1.73
Hyperactivity	19.53	11.49	14.72	10.16	14.87	9.23	3.63	0.001*	0.42	3.26	0.01	0.42
Inappropriate speech	5.23	2.78	3.37	2.23	3.14	2.18	3.12	0.01	0.69	3.95	0.00*	0.78

# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES<sup>b</sup></i>	<i>t</i>	<i>p</i>	<i>ES<sup>b</sup></i>
<i>Parent Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	19.84	9.53	9.09	4.59	8.10	5.90	4.09	0.01*	1.35	3.92	0.00*	1.39
Total wake time (min)	58.31	24.31	27.54	27.92	22.70	22.22	5.92	0.00*	1.10	5.88	0.00*	1.43
Total sleep time (min)	447.66	88.48	485.79	73.35	465.07	72.38	−2.17	0.05	0.44	−0.89	0.39	0.20
Sleep efficiency (%) <sup>c</sup>	85.39	5.13	96.43	2.52	96.13	3.41	−7.42	0.00*	2.56	−6.45	0.00*	2.31
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	25.44	7.45	13.37	6.79	12.69	6.11	4.45	0.001*	1.55	4.70	0.001*	1.75
Total wake time (min)	79.19	23.41	58.05	25.85	48.41	15.93	5.01	0.001*	0.78	5.17	0.001*	1.40
Total sleep time (min)	438.76	52.52	473.89	46.44	467.73	44.87	−8.69	0.00*	0.66	−2.89	0.01*	.56
Sleep efficiency (%) <sup>c</sup>	83.25	3.03	87.34	2.09	87.82	2.41	7.15	0.00*	1.44	−6.63	0.00*	1.52
Daytime functioning – Electronic daily diaries												
Fatigue	59.20	28.62	34.87	21.40	39.39	17.99	5.10	0.00*	0.90	4.10	0.001*	0.78



# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES<sup>b</sup></i>	<i>t</i>	<i>p</i>	<i>ES<sup>b</sup></i>
<i>Parent Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	19.84	9.53	9.09	4.59	8.10	5.90	4.09	0.01*	1.35	3.92	0.00*	1.39
Total wake time (min)	58.31	24.31	27.54	27.92	22.70	22.22	5.92	0.00*	1.10	5.88	0.00*	1.43
Total sleep time (min)	447.66	88.48	485.79	73.35	465.07	72.38	−2.17	0.05	0.44	−0.89	0.39	0.20
Sleep efficiency (%) <sup>c</sup>	85.39	5.13	96.43	2.52	96.13	3.41	−7.42	0.00*	2.56	−6.45	0.00*	2.31
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	25.44	7.45	13.37	6.79	12.69	6.11	4.45	0.001*	1.55	4.70	0.001*	1.75
Total wake time (min)	79.19	23.41	58.05	25.85	48.41	15.93	5.01	0.001*	0.78	5.17	0.001*	1.40
Total sleep time (min)	438.76	52.52	473.89	46.44	467.73	44.87	−8.69	0.00*	0.66	−2.89	0.01*	.56
Sleep efficiency (%) <sup>c</sup>	83.25	3.03	87.34	2.09	87.82	2.41	7.15	0.00*	1.44	−6.63	0.00*	1.52
Daytime functioning – Electronic daily diaries												
Fatigue	59.20	28.62	34.87	21.40	39.39	17.99	5.10	0.00*	0.90	4.10	0.001*	0.78

# Single Arm (N=17) In-Person 8-Session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to posttreatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>P</i>	<i>ES<sup>b</sup></i>	<i>t</i>	<i>p</i>	<i>ES<sup>b</sup></i>
<i>Parent Outcomes</i>												
Subjective sleep <sup>c</sup> – Electronic sleep diaries												
Sleep latency (min)	19.84	9.53	9.09	4.59	8.10	5.90	4.09	0.01*	1.35	3.92	0.00*	1.39
Total wake time (min)	58.31	24.31	27.54	27.92	22.70	22.22	5.92	0.00*	1.10	5.88	0.00*	1.43
Total sleep time (min)	447.66	88.48	485.79	73.35	465.07	72.38	−2.17	0.05	0.44	−0.89	0.39	0.20
Sleep efficiency (%) <sup>c</sup>	85.39	5.13	96.43	2.52	96.13	3.41	−7.42	0.00*	2.56	−6.45	0.00*	2.31
Objective sleep <sup>c</sup> – Actigraphy												
Sleep latency (min)	25.44	7.45	13.37	6.79	12.69	6.11	4.45	0.001*	1.55	4.70	0.001*	1.75
Total wake time (min)	79.19	23.41	58.05	25.85	48.41	15.93	5.01	0.001*	0.78	5.17	0.001*	1.40
Total sleep time (min)	438.76	52.52	473.89	46.44	467.73	44.87	−8.69	0.00*	0.66	−2.89	0.01*	.56
Sleep efficiency (%) <sup>c</sup>	83.25	3.03	87.34	2.09	87.82	2.41	7.15	0.00*	1.44	−6.63	0.00*	1.52
Daytime functioning – Electronic daily diaries												
Fatigue	59.20	28.62	34.87	21.40	39.39	17.99	5.10	0.00*	0.90	4.10	0.001*	0.78

# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
Child outcomes												
<i>Subjective sleep<sup>c</sup>—Electronic sleep diaries</i>												
Sleep latency (min)	54.63	27.36	21.10	13.51	21.94	10.50	4.18	0.01*	1.45	4.16	0.01*	1.47
Total wake time (min)	69.27	42.84	23.19	12.13	19.66	10.32	3.84	0.01*	1.36	4.50	0.001*	1.48
Total sleep time (min)	523.78	59.30	575.95	27.54	580.20	27.56	-4.23	0.001*	1.05	-4.12	0.01*	1.14
Sleep efficiency (%) <sup>c</sup>	87.85	4.94	95.8	1.93	96.46	1.81	-5.78	0.00*	1.97	-6.47	0.00*	2.22
<i>Objective sleep<sup>c</sup>—Actigraphy</i>												
Sleep latency (min)	34.58	18.73	17.05	9.23	18.13	8.95	4.88	0.001*	1.10	4.86	0.001*	1.04
Total wake time (min)	114.57	33.48	82.04	28.54	82.99	30.74	10.21	0.00*	0.97	6.65	0.00*	0.91
Total sleep time (min)	519.87	40.47	553.12	23.56	553.15	26.74	-4.58	0.00*	1.10	-3.59	0.00*	1.12
Sleep efficiency (%) <sup>c</sup>	79.85	4.59	84.56	3.43	85.16	3.07	-4.32	0.001*	1.08	-4.72	0.001*	1.27
<i>Bedtime/wake time regulation<sup>c,d</sup></i>												
Bedtime variability (min)	51.19	29.98	21.36	17.54	19.23	16.25	3.42	0.01*	1.13	4.35	0.001*	1.23
Wake time variability (min)	47.54	18.49	17.71	11.28	12.56	9.23	5.43	0.00*	1.81	8.37	0.00*	2.27
<i>Daytime functioning—Aberrant Behavior Checklist</i>												
Irritability	17.98	6.15	12.46	6.58	12.78	6.74	3.78	0.00*	0.86	3.78	0.00*	0.75
Lethargy	9.47	8.73	3.95	7.23	4.07	7.41	4.64	0.00*	0.64	4.22	0.00*	0.62
Stereotypy	2.98	1.54	1.21	1.23	1.45	0.87	5.05	0.00*	1.16	4.98	0.00*	1.14
Hyperactivity	19.87	10.53	15.68	9.15	13.53	9.87	4.55	0.001*	0.58	2.88	0.01	0.40
Inappropriate speech	5.37	2.87	3.45	1.98	3.24	2.04	3.10	0.01	0.72	3.85	0.00*	0.80

(McCrae et al., 2020)

# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
Child outcomes												
<i>Subjective sleep<sup>c</sup>—Electronic sleep diaries</i>												
Sleep latency (min)	54.63	27.36	21.10	13.51	21.94	10.50	4.18	0.01*	1.45	4.16	0.01*	1.47
Total wake time (min)	69.27	42.84	23.19	12.13	19.66	10.32	3.84	0.01*	1.36	4.50	0.001*	1.48
Total sleep time (min)	523.78	59.30	575.95	27.54	580.20	27.56	-4.23	0.001*	1.05	-4.12	0.01*	1.14
Sleep efficiency (%) <sup>c</sup>	87.85	4.94	95.8	1.93	96.46	1.81	-5.78	0.00*	1.97	-6.47	0.00*	2.22
<i>Objective sleep<sup>c</sup>—Actigraphy</i>												
Sleep latency (min)	34.58	18.73	17.05	9.23	18.13	8.95	4.88	0.001*	1.10	4.86	0.001*	1.04
Total wake time (min)	114.57	33.48	82.04	28.54	82.99	30.74	10.21	0.00*	0.97	6.65	0.00*	0.91
Total sleep time (min)	519.87	40.47	553.12	23.56	553.15	26.74	-4.58	0.00*	1.10	-3.59	0.00*	1.12
Sleep efficiency (%) <sup>c</sup>	79.85	4.59	84.56	3.43	85.16	3.07	-4.32	0.001*	1.08	-4.72	0.001*	1.27
<i>Bedtime/wake time regulation<sup>c,d</sup></i>												
Bedtime variability (min)	51.19	29.98	21.36	17.54	19.23	16.25	3.42	0.01*	1.13	4.35	0.001*	1.23
Wake time variability (min)	47.54	18.49	17.71	11.28	12.56	9.23	5.43	0.00*	1.81	8.37	0.00*	2.27
<i>Daytime functioning—Aberrant Behavior Checklist</i>												
Irritability	17.98	6.15	12.46	6.58	12.78	6.74	3.78	0.00*	0.86	3.78	0.00*	0.75
Lethargy	9.47	8.73	3.95	7.23	4.07	7.41	4.64	0.00*	0.64	4.22	0.00*	0.62
Stereotypy	2.98	1.54	1.21	1.23	1.45	0.87	5.05	0.00*	1.16	4.98	0.00*	1.14
Hyperactivity	19.87	10.53	15.68	9.15	13.53	9.87	4.55	0.001*	0.58	2.88	0.01	0.40
Inappropriate speech	5.37	2.87	3.45	1.98	3.24	2.04	3.10	0.01	0.72	3.85	0.00*	0.80

# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
Child outcomes												
<i>Subjective sleep<sup>c</sup>—Electronic sleep diaries</i>												
Sleep latency (min)	54.63	27.36	21.10	13.51	21.94	10.50	4.18	0.01*	1.45	4.16	0.01*	1.47
Total wake time (min)	69.27	42.84	23.19	12.13	19.66	10.32	3.84	0.01*	1.36	4.50	0.001*	1.48
Total sleep time (min)	523.78	59.30	575.95	27.54	580.20	27.56	-4.23	0.001*	1.05	-4.12	0.01*	1.14
Sleep efficiency (%) <sup>c</sup>	87.85	4.94	95.8	1.93	96.46	1.81	-5.78	0.00*	1.97	-6.47	0.00*	2.22
<i>Objective sleep<sup>c</sup>—Actigraphy</i>												
Sleep latency (min)	34.58	18.73	17.05	9.23	18.13	8.95	4.88	0.001*	1.10	4.86	0.001*	1.04
Total wake time (min)	114.57	33.48	82.04	28.54	82.99	30.74	10.21	0.00*	0.97	6.65	0.00*	0.91
Total sleep time (min)	519.87	40.47	553.12	23.56	553.15	26.74	-4.58	0.00*	1.10	-3.59	0.00*	1.12
Sleep efficiency (%) <sup>c</sup>	79.85	4.59	84.56	3.43	85.16	3.07	-4.32	0.001*	1.08	-4.72	0.001*	1.27
<i>Bedtime/wake time regulation<sup>c,d</sup></i>												
Bedtime variability (min)	51.19	29.98	21.36	17.54	19.23	16.25	3.42	0.01*	1.13	4.35	0.001*	1.23
Wake time variability (min)	47.54	18.49	17.71	11.28	12.56	9.23	5.43	0.00*	1.81	8.37	0.00*	2.27
<i>Daytime functioning—Aberrant Behavior Checklist</i>												
Irritability	17.98	6.15	12.46	6.58	12.78	6.74	3.78	0.00*	0.86	3.78	0.00*	0.75
Lethargy	9.47	8.73	3.95	7.23	4.07	7.41	4.64	0.00*	0.64	4.22	0.00*	0.62
Stereotypy	2.98	1.54	1.21	1.23	1.45	0.87	5.05	0.00*	1.16	4.98	0.00*	1.14
Hyperactivity	19.87	10.53	15.68	9.15	13.53	9.87	4.55	0.001*	0.58	2.88	0.01	0.40
Inappropriate speech	5.37	2.87	3.45	1.98	3.24	2.04	3.10	0.01	0.72	3.85	0.00*	0.80

(McCrae et al., 2020)

# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
<b>Parent outcomes</b>												
<i>Subjective sleep<sup>c</sup>—electronic sleep diaries</i>												
Sleep latency (min)	22.51	10.56	13.04	5.89	10.13	7.2	3.11	0.01*	1.03	3.51	0.00*	1.27
Total wake time (min)	61.58	27.56	36.48	29.57	29.34	23.69	4.24	0.00*	0.82	4.74	.00*	1.17
Total sleep time (min)	453.87	85.26	479.72	73.58	478.72	71.43	-1.49	0.17	0.30	-1.25	0.24	0.29
Sleep efficiency (%) <sup>c</sup>	84.86	5.54	93.30	2.58	92.72	2.32	-5.19	0.00*	1.82	-6.21	0.00*	1.72
<i>Objective sleep<sup>c</sup>—actigraphy</i>												
Sleep latency (min)	29.45	7.87	19.22	7.72	20.47	5.87	3.56	0.00*	1.22	3.44	0.01*	1.20
Total wake time (min)	77.24	21.68	48.37	27.19	45.01	14.84	6.50	0.00*	1.09	6.33	0.00*	1.61
Total sleep time (min)	435.46	56.48	469.90	44.87	466.72	63.21	-5.21	0.00*	0.63	-5.31	0.00*	0.49
Sleep efficiency (%) <sup>c</sup>	83.54	4.25	89.48	3.59	88.95	3.41	7.51	0.00*	1.40	-6.59	0.00*	1.31
<i>Daytime functioning—electronic daily diaries</i>												
Fatigue	61.58	29.46	42.29	17.89	43.23	18.24	3.88	0.00*	0.74	3.79	0.00*	0.70

# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
<i>Parent outcomes</i>												
<i>Subjective sleep<sup>c</sup>—electronic sleep diaries</i>												
Sleep latency (min)	22.51	10.56	13.04	5.89	10.13	7.2	3.11	0.01*	1.03	3.51	0.00*	1.27
Total wake time (min)	61.58	27.56	36.48	29.57	29.34	23.69	4.24	0.00*	0.82	4.74	.00*	1.17
Total sleep time (min)	453.87	85.26	479.72	73.58	478.72	71.43	-1.49	0.17	0.30	-1.25	0.24	0.29
Sleep efficiency (%) <sup>c</sup>	84.86	5.54	93.30	2.58	92.72	2.32	-5.19	0.00*	1.82	-6.21	0.00*	1.72
<i>Objective sleep<sup>c</sup>—actigraphy</i>												
Sleep latency (min)	29.45	7.87	19.22	7.72	20.47	5.87	3.56	0.00*	1.22	3.44	0.01*	1.20
Total wake time (min)	77.24	21.68	48.37	27.19	45.01	14.84	6.50	0.00*	1.09	6.33	0.00*	1.61
Total sleep time (min)	435.46	56.48	469.90	44.87	466.72	63.21	-5.21	0.00*	0.63	-5.31	0.00*	0.49
Sleep efficiency (%) <sup>c</sup>	83.54	4.25	89.48	3.59	88.95	3.41	7.51	0.00*	1.40	-6.59	0.00*	1.31
<i>Daytime functioning—electronic daily diaries</i>												
Fatigue	61.58	29.46	42.29	17.89	43.23	18.24	3.88	0.00*	0.74	3.79	0.00*	0.70



# Single Arm (N=15) Telehealth 8-session CBT-I Pilot

Measure	Baseline		Post-treatment		1-month follow-up		Base to post-treatment <sup>a</sup>			Base to 1-month follow-up <sup>a</sup>		
	M	SD	M	SD	M	SD	t	p	ES <sup>b</sup>	t	p	ES <sup>b</sup>
<i>Parent outcomes</i>												
<i>Subjective sleep<sup>c</sup>—electronic sleep diaries</i>												
Sleep latency (min)	22.51	10.56	13.04	5.89	10.13	7.2	3.11	0.01*	1.03	3.51	0.00*	1.27
Total wake time (min)	61.58	27.56	36.48	29.57	29.34	23.69	4.24	0.00*	0.82	4.74	.00*	1.17
Total sleep time (min)	453.87	85.26	479.72	73.58	478.72	71.43	-1.49	0.17	0.30	-1.25	0.24	0.29
Sleep efficiency (%) <sup>c</sup>	84.86	5.54	93.30	2.58	92.72	2.32	-5.19	0.00*	1.82	-6.21	0.00*	1.72
<i>Objective sleep<sup>c</sup>—actigraphy</i>												
Sleep latency (min)	29.45	7.87	19.22	7.72	20.47	5.87	3.56	0.00*	1.22	3.44	0.01*	1.20
Total wake time (min)	77.24	21.68	48.37	27.19	45.01	14.84	6.50	0.00*	1.09	6.33	0.00*	1.61
Total sleep time (min)	435.46	56.48	469.90	44.87	466.72	63.21	-5.21	0.00*	0.63	-5.31	0.00*	0.49
Sleep efficiency (%) <sup>c</sup>	83.54	4.25	89.48	3.59	88.95	3.41	7.51	0.00*	1.40	-6.59	0.00*	1.31
<i>Daytime functioning—electronic daily diaries</i>												
Fatigue	61.58	29.46	42.29	17.89	43.23	18.24	3.88	0.00*	0.74	3.79	0.00*	0.70



# Sleep Improvements After 4 Weeks

- In-person delivery (comparing 4 and 8 weeks)
  - Similar ESs
    - TWT, TST, SE
  - Larger ES at 4 weeks
    - SOL
- Remote delivery (comparing 4 and 8 weeks)
  - Similar ESs
    - SOL, TWT, TST, SE



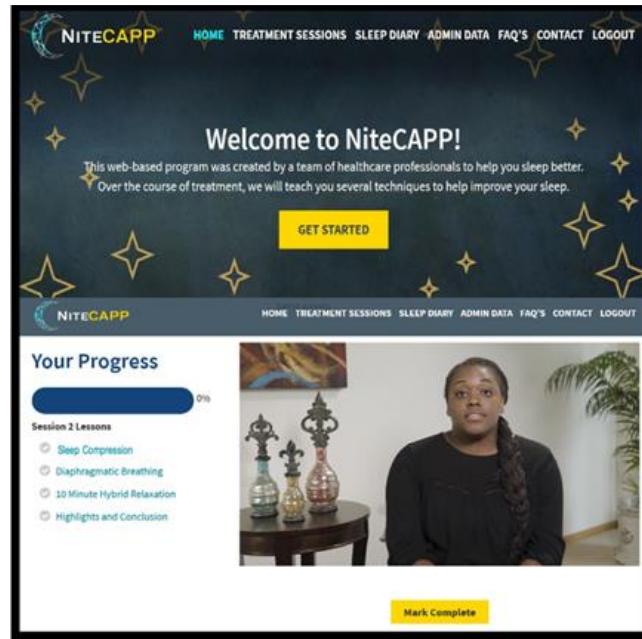
(McCrae et al., in prep)



# NiteCAPP<sup>SM</sup> Stage 1A Development

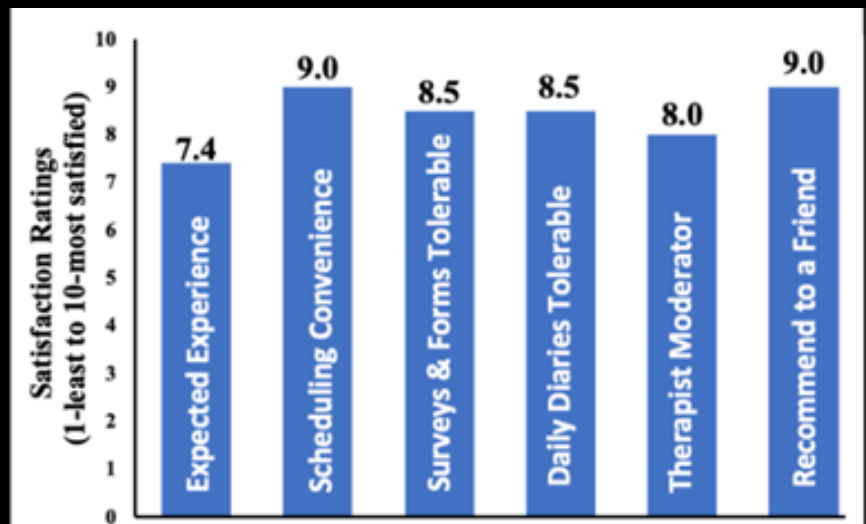
- Medical Research Council recommendations<sup>10</sup> for evaluating complex medical interventions
- Tailored for dementia caregivers
- 1. Local care providers tested the NiteCAPP website
  - Open-ended verbal and written feedback
- 2. FGs: adults with insomnia (n=5) & providers (n=7)
  - Given logins and passwords to explore the NiteCAPP<sup>SM</sup>
  - IIUQ: High utility ratings (4+/5)
  - Open ended verbal comments

(McCrae et al., 2023)

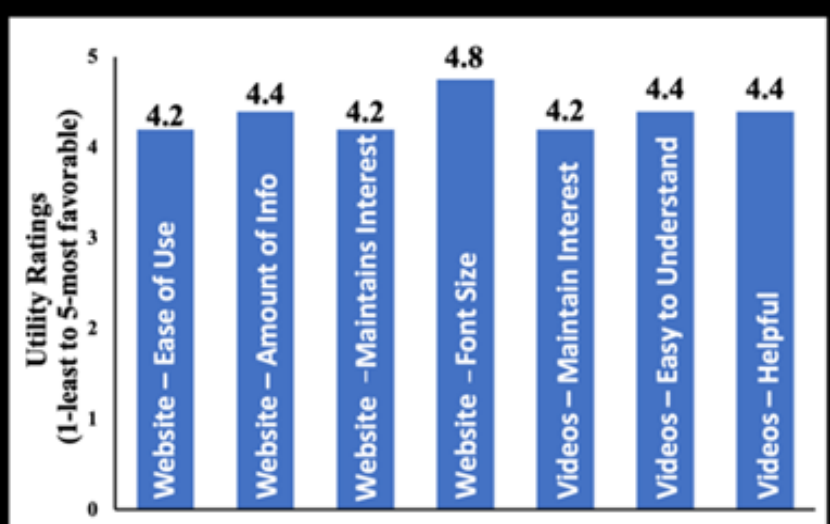


# NiteCAPP<sup>SM</sup> Stage 1A Development

*NiteCAPP Stage 1A satisfaction ratings.*



*NiteCAPP Stage 1A utility ratings.*



# NiteCAPP<sup>SM</sup> Stage 1B Development

- Single arm pilot ( $n=5$ ,  $Mage=62.4$ ,  $SD=18.2$ )

Measure	Base			Post			Base to Post			
	<i>M</i>	<i>SD</i>	<i>SE</i>	<i>M</i>	<i>SD</i>	<i>SE</i>	$\Delta$	<i>t</i>	<i>p</i>	<i>ES</i> <sup>†</sup>
Subjective sleep <sup>§</sup>										
Sleep onset latency	23.22	8.67	3.88	10.69	4.34	1.94	12.53	4.01	.01*	1.46 large
Wake after sleep onset	54.95	23.03	10.30	22.30	8.70	3.89	32.65	4.05	.01*	1.50 large
Sleep efficiency	79.64	9.92	4.44	92.67	1.96	.88	13.03	3.53	.02*	1.46 large
Insomnia Severity Scale	15.20	4.09	1.82	8.00	6.00	2.68	7.20	2.25	.04*	.81 large
Subjective Arousal										
Perceived Stress Scale	25.40	5.50	2.46	20.00	8.97	4.01	5.40	2.09	.05*	.58 moderate
Mood										
Beck Depression Inv-II	11.80	4.32	1.93	6.20	2.95	1.32	5.60	2.89	.02*	1.21 large
State-Trait Anxiety Inv	61.40	11.08	4.96	57.20	8.67	3.88	4.20	1.36	.12	.34 small
Subjective Cognition										
Cognitive Failures Ques	43.80	14.38	6.43	39.20	10.52	4.71	4.60	2.44	.04*	.29 small

# NiteCAPP<sup>SM</sup> Stage 1B Development

- Single arm pilot ( $n=5$ ,  $Mage=62.4$ ,  $SD=18.2$ )

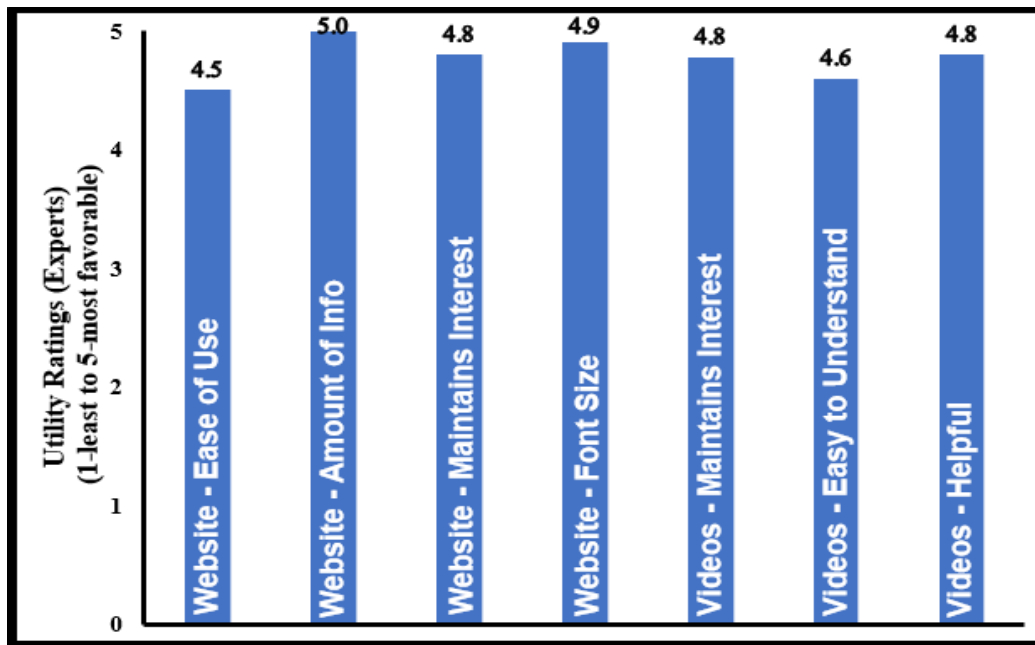
Measure	Base			Post			Base to Post			
	<i>M</i>	<i>SD</i>	<i>SE</i>	<i>M</i>	<i>SD</i>	<i>SE</i>	$\Delta$	<i>t</i>	<i>p</i>	<i>ES</i> <sup>†</sup>
Subjective sleep <sup>§</sup>										
Sleep onset latency	23.22	8.67	3.88	10.69	4.34	1.94	12.53	4.01	.01*	1.46 large
Wake after sleep onset	54.95	23.03	10.30	22.30	8.70	3.89	32.65	4.05	.01*	1.50 large
Sleep efficiency	79.64	9.92	4.44	92.67	1.96	.88	13.03	3.53	.02*	1.46 large
Insomnia Severity Scale	15.20	4.09	1.82	8.00	6.00	2.68	7.20	2.25	.04*	.81 large
Subjective Arousal										
Perceived Stress Scale	25.40	5.50	2.46	20.00	8.97	4.01	5.40	2.09	.05*	.58 moderate
Mood										
Beck Depression Inv-II	11.80	4.32	1.93	6.20	2.95	1.32	5.60	2.89	.02*	1.21 large
State-Trait Anxiety Inv	61.40	11.08	4.96	57.20	8.67	3.88	4.20	1.36	.12	.34 small
Subjective Cognition										
Cognitive Failures Ques	43.80	14.38	6.43	39.20	10.52	4.71	4.60	2.44	.04*	.29 small

(McCrae et al., 2023)



# NiteCAPP<sup>SM</sup> SPECTRUM Stage 1A Development

- Care providers (n=12) with ASD experience tested NiteCAPP<sup>SM</sup>
  - Open-ended written feedback
  - IIUQ: 4+/5

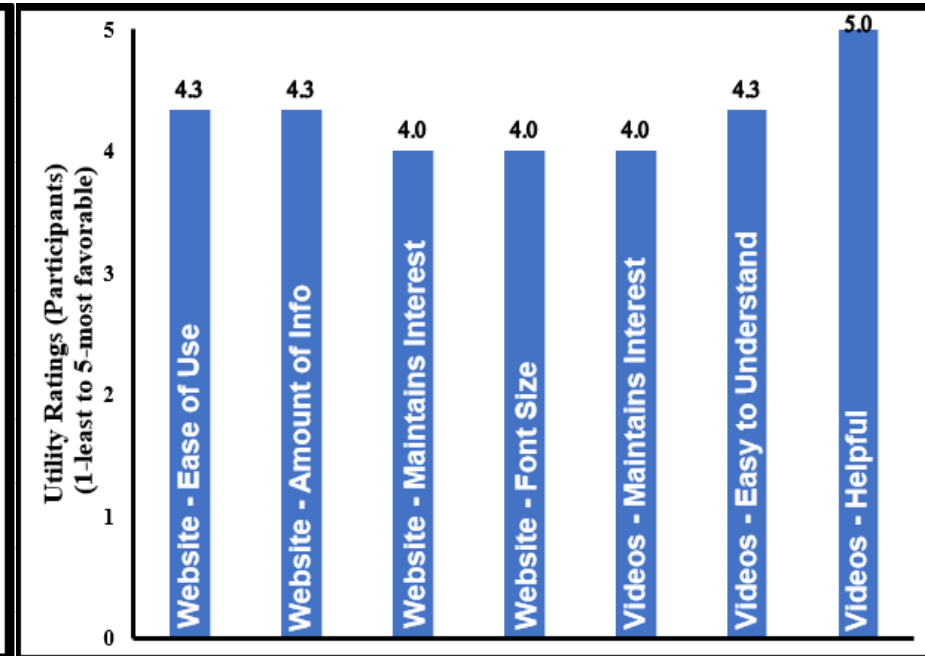
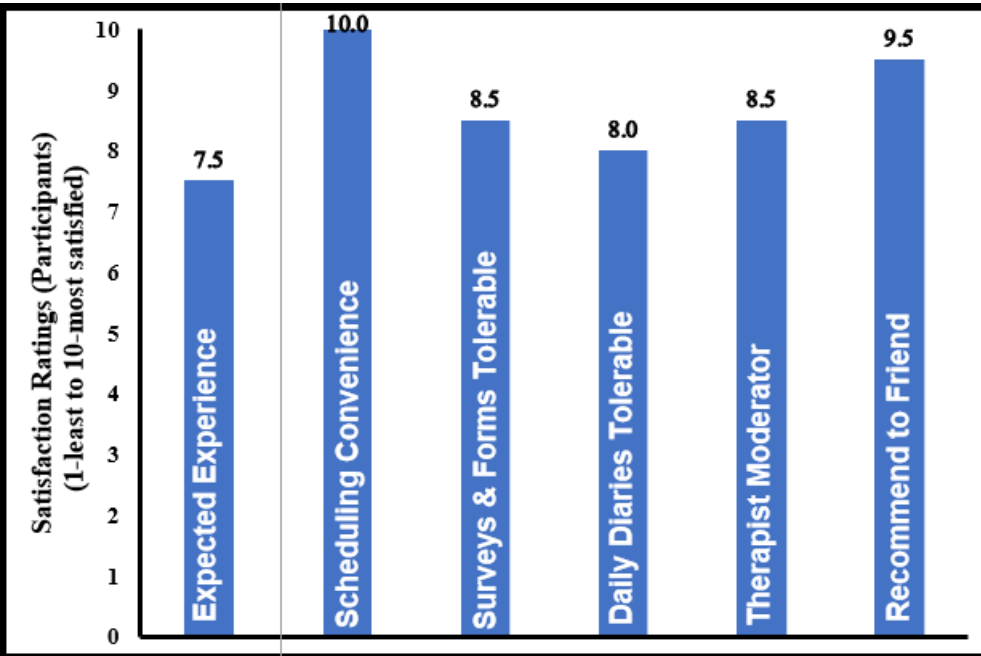


(McCrae et al., in prep)



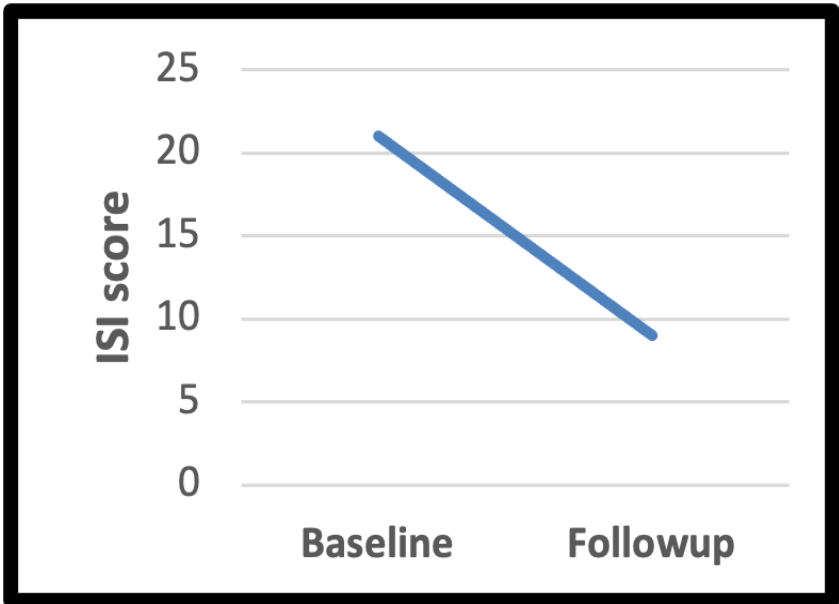
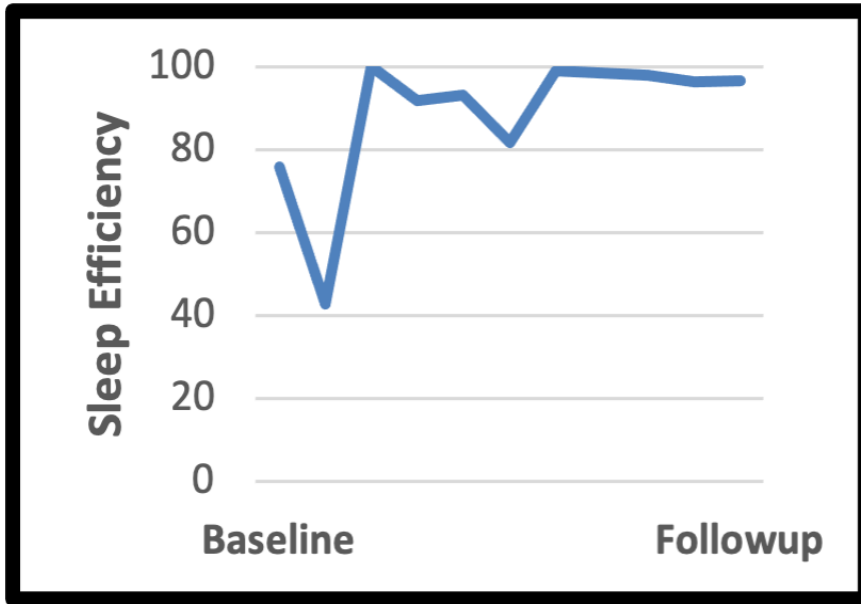
# NiteCAPP<sup>SM</sup> SPECTRUM Stage 1B Development

- Single arm pilot with autistic adults ( $n=2$ ,  $Mage=25.2$ ,  $SD=1.2$ ) and the parent of an autistic adult ( $n=1$ )



# NiteCAPP<sup>SM</sup> SPECTRUM Stage 1B Development

- Improved insomnia severity (right) in one adult with ASD (right)
- Improved sleep efficiency (left) in another



# NiteCAPP<sup>SM</sup> SPECTRUM Stage 1B Development

*NiteCAPP<sup>SM</sup> primary care providers with autism expertise and autistic adults evaluations of site features.*

NiteCAPP feature	(+) Positive and (-) Negative Themes	Quotes <sup>b</sup>
Written material	+ Comprehensive for target population - Reduce level of the language	<i>Written material is good, easy to follow. [AASD-001]</i> <i>The written material seemed appropriate and easy to understand. [PCPAE-001]</i> <i>Too much written, language heavy information. [PCPAE-007]</i>
Audiovisual material	+ Rich, engaging information + Important communication tool - Reduce background graphics - Improve audio quality - Reduce background noise	<i>Videos are a good length and content and the voices are soothing and easy to understand. [AASD-001]</i> <i>Videos were well-done, easy to follow. [PCP-AE-001]</i> <i>The videos were great, but the audio was very low in volume. [PCPAE-003]</i> <i>I think the videos are short, simple, and easy to understand. [PCPAE-008]</i>
Aesthetics	+ Appealing design/logo + Displayed in sections well - Less and more direct text - Use bullet points	<i>I especially appreciate that it is broken up into sections. [AASD-001]</i> <i>It may be clearer to have less and more direct text. It's still a huge improvement over most websites, however. [PCPAE-004]</i> <i>Bullet pointing could increase readability. Background graphics could be toned down to reduce any chances of distractions. [PCPAE-006]</i>
Navigation	+ Good layout and links/tabs to intervention materials - Increase engagement through more rewards	<i>You might consider making the "mark complete" button at the end of each lesson a bit more prominent. [PCPAE-001]</i> <i>I really felt like the site was very user friendly and useful! [PCPAE-002]</i>

<sup>b</sup>PCPAE (number) - ASD expert primary care provider participant number. AASD (number) – adult with ASD participant number.

(McCrae et al., in prep)



# NiteCAPP<sup>SM</sup> SPECTRUM Jr Stage 1B Development

- Care providers (n = 2) with pediatric ASD experience
  - IIUQ
    - Ease of use: 4.5
    - Website appropriate: 4.5
    - Maintained interest: 4
    - Videos maintained interest: 3.5
    - Videos easy to understand: 4
    - Videos helpful: 3.5



(McCrae et al., in prep)

# NiteCAPP<sup>SM</sup> SPECTRUM Jr Stage 1B Development

- Care providers (n = 2) with pediatric ASD experience
  - Positive Comments
    - *[Videos] easy to understand*
    - *Useful material, a bit text dense*
    - *Good. Jargon is explained. Step-by-step instructions.*
  - Comments for Improvement
    - *Reduce text amount, more bullet points*
    - *Maybe a lower level of literacy would be better for some families*



# Future Directions

- Pilot NiteCAPP<sup>SM</sup> SPECTRUM Jr in sample of autistic children (6-12)
  - Determine efficacy in a fully-powered sample
- Expand NiteCAPP<sup>SM</sup> SPECTRUM Jr
  - Autistic adolescents



## Special Thanks To:

**Dr. Christina McCrae, PhD, DBSM, FSBSM, FAASM**  
Study PI, Director of the McCrae Sleep Research Lab  
Director, Sleep and Health Innovations in Neurobehavioral  
(SHiNE) Science Center



**McCrae Sleep Research Lab Team**