Effects of Topiramate in Adults With Prader-Willi Syndrome

Nathan A. Shapira, Mary C. Lessig, Mark H. Lewis, Wayne K. Goodman, and Daniel J. Driscoll
University of Florida

Abstract

Prader-Willi syndrome is a multisystem neurogenetic obesity disorder with behavioral manifestations, including hyperphagia, compulsive behavior, self-injury, and mild to moderate mental retardation. In an 8-week open-label study, we evaluated adjunctive therapy with the anticonvulsant topiramate in 8 adults with Prader-Willi syndrome. Appetite was measured by a 1-hour access to food four times throughout the study and quantified with a visual analogue scale. Topiramate did not significantly change calories consumed, Body Mass Index, or increase self-reported appetite. In addition, there were no significant changes in compulsions. Surprisingly, topiramate treatment resulted in a clinically significant improvement in the self-injury (i.e., skin-picking) that is characteristic of this syndrome. Potential benefits of topiramate for self-injury should be evaluated further in controlled trials.

Prader-Willi syndrome is a multisystem neurogenetic disorder characterized by neonatal failure-to-thrive, hypogonadism, dysmorphic features, mild to moderate mental retardation, severe hyperphagia, and childhood-onset obesity (Prader, Labhart, & Willi, 1956; A. Martin et al., 1998). Also common in this population are behavioral/psychiatric manifestations, including self-injury, explosive outbursts, obsessive ruminations, and compulsive behaviors.

Limited use of appetite suppressants and anorectic agents have been reported in the literature for individuals with Prader-Willi syndrome. Selikowitz, Sunman, Pendergast, and Wright (1990) reported on the use of fenfluramine, which resulted in significant weight loss, an improvement in behaviors associated with the exposure to food, and a decrease in aggressive impulses in 15 individuals with the syndrome. Due to cardiovascular consequences, however, fenfluramine is currently not available for use. In three reports of the anorectic mazindol, available in Japan, researchers demonstrated its benefit for appetite and weight control in 5 individuals with Prader-Willi syndrome (Inoue, 1995; Itoh, Koeda, Ohno, & Takeshita, 1995; Inui et al., 1997). Although opiate antagonists have been reported to be helpful in obese and bulimic patients (de Zwaan & Mitchell, 1992), naloxone failed to alter food intake in individuals with Prader-Willi syndrome (Zipf & Berntson, 1987).

Small open-label studies have demonstrated that selective serotonin reuptake inhibitors (SSRIs) can be helpful for self-injurious, aggressive, affective, and compulsive behaviors in these individuals (A. Martin et al., 1998). Unfortunately, SSRIs can exacerbate these behaviors during the initiation/titration phases (A. Martin et al., 1998). Antiepileptic and antipsychotic medications are sometimes helpful in individuals with Prader-Willi syndrome for targeting impulsive and psychotic behavior, although these agents can increase weight (Durst, Rubin-Jabotinsky, Raskin, Katz, & Zislin, 2000; A. Martin et al., 1998; Stein, Keeting, Zar, & Hollander, 1994). Recently, Durst et al. (2000) reported on the benefits of the use of the atypical antipsychotic risperidone for behavioral management without significant increases in

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weight. Classically, atypical antipsychotics have been reported to induce weight gain, although it is recognized that the risk of weight gain with risperidone therapy is not as great as other neuroleptics, for example, clozapine or olanzapine (Baptista, Kin, Beaulieu, & de Baptista, 2002).

Only small case reports (1 to 3 subjects) on the use of antiepileptic medications for behavioral management have previously been reported in the literature (Gupta, Fish, & Yerevanian, 1987; Jerome 1993; A. Martin et al., 1998; Tu, Hartridge, & Izawa, 1992). However, Smathers, Wilson, and Nigro (2003) reported on the successful use of the antiepileptic topiramate in 8 children and adolescents with Prader-Willi syndrome to control weight and behavior. Topiramate is a novel antiepileptic agent associated with appetite suppression and weight loss (Privitera, 1997). Furthermore, this medication has been reported to be helpful in the treatment of binge-eating disorder (McElroy et al., 2003; Shapira, Goldsmith, & McElroy, 2000) and may have mood-stabilizing properties (McElroy et al., 2002).

Individuals with Prader-Willi syndrome often live in controlled and behaviorally monitored environments, such as group homes, where their access to food is limited. Even when in a controlled environment, some individuals with Prader-Willi syndrome continue to forage and hoard food, making it difficult to place them in programs outside of these controlled settings (Hoffman, Aultman, & Pipes, 1992; Page, Stanley, Richman, Deal, & Iwata 1983). We evaluated the efficacy and safety of open-label topiramate in adults with Prader-Willi syndrome as an appetite-regulating medication. Following previous observations by the authors of the effects of topiramate in binge-eating disorder and, subsequently, antipsychotic-induced weight gain, we hypothesized that topiramate would decrease appetite and manage weight in individuals with Prader-Willi syndrome (Lessig, Shapira, & Murphy 2001; McElroy et al., 2003; Shapira et al., 2000). In addition, we evaluated whether topiramate would also affect other behaviors associated with this syndrome. Changes in appetite were quantified in terms of appetite regulatory effects; these effects were identified as a decrease in the number of consumed calories as directly measured and incidences of active food foraging behavior.

Method

Participants

The 9 participants enrolled in this 8-week open-label trial of topiramate, described in Table 1, were residents of local group homes specializing in the care of persons with Prader-Willi syndrome. Participants were confirmed as having Prader-Willi syndrome through chromosomal and DNA molecular analyses (Glenn et al., 1996). Participants were recruited through a letter approved by the Institutional Review Board of the University of Florida Health Science Center. This recruitment letter was sent to their parents prior to participation to inform them of the study and its goals;

Table 1. Participant Demographics

Participant/ Gender	Age at enrollment	Molecular class	BMI[d] enrollment (and completion)	Dose of topiramate at study completion (mg)	Concomitant psychotropic medications at enrollment
1/F	19	Deletion	25.24 (25.1)	150	Fluoxetine, naltrexone
2/M	30	Deletion	26.8 (26.4)	175	None
3/M	29	Deletion	35.23 (34.5)	200	None[a]
4/F	26	UPD[c]	24.7 (23.9)	150	Divalproex sodium, fluoxetine, lorazepam
5/F	32	Deletion	29.35 (30.2)	175	Fluoxetine
6/M[b]	19		N/A	N/A	N/A
7/F	36	Deletion	31.77 (33.4)	175	Venlafaxine
8/M	25	UPD	37.8 (37.8)	150	Divalproex sodium, fluoxetine
9/F	38	Deletion	30.36 (28.13)	125	Venlafaxine

[a]Initiated sertraline therapy during study interventions. [b]Participant 6 was not included in analysis due to exclusion from study interventions. [c]Uniparental disomy. [d]Body Mass Index.

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included with the letter was a copy of the informed consent document, which was not to be signed. Full written informed consent was obtained from participants and witnessed by either a parent or group home operator. One participant during screening was excluded due to behavioral outbursts that met exclusion criteria; however, these outbursts would not have ruled the potential participant out for clinical treatment with topiramate. Eight participants initiated and completed the study (5 female, 3 male; 6 deletion, 2 uniparental disomy; mean age = 29.5 years, standard deviation [*SD*] = 6.1).

Procedure

Participants began topiramate following a 1-week screening phase that involved laboratory evaluations and a medical/psychiatric history, including the Structured Clinical Interview for the Diagnostic and Statistical Manual for Mental Disorders, Fourth Revision—DSM-IV—Patient Version (American Psychiatric Association, 2000). Group home operators and staff members maintained detailed records of behavioral outbursts, weight, and daily activities. We were granted access to these records during the screening process for review as well as during participation for monitoring purposes after the Informed Consent Document and a medical record release were signed.

Topiramate therapy was begun at a dose of 25 mg orally at bedtime at baseline and increased weekly by a dose of 25 mg at bedtime. We determined whether to increase participants' medication dose based on side effect profile (e.g., presence of parasthesias or significant sedation) and response (e.g., loss of weight). Following the beneficial finding that topiramate positively affected skin-picking behavior (observed initially in the first participant), attenuation of self-injury was also factored into whether to increase their study medication dose or maintain the dose until the next week, although the primary indicators for increasing the dose were the presence of side effects and topiramate's effect on appetite and related behaviors. Conventional dosing regimens warrant a twice a day dosing schedule. Due to our clinical experience, a single dosing schedule of prescribed topiramate was initiated to minimize daytime sedation and other side effects. In addition, in order to further minimize the side effect profile, we titrated doses in a slow, linear fashion of approximately 25 to 50 mg weekly increases.

Baseline and weekly visits included a battery of standardized rating measurements, the Aberrant Behavior Checklist (Aman, Singh, Stewart, & Field, 1985); the Repetitive Behavior Scale, including the Self-Injury and Self-Restraint Checklist (Bodfish, Symons, & Lewis, 1999; Bodfish, Symons, Parker, & Lewis, 2000; Powell, Bodfish, Parker, Crawford, & Lewis, 1996), the Yale-Brown Obsessive-Compulsive Scale Checklist (Goodman et al., 1989), and the Clinical Global Impression Scale. Problems with verbal fluency and a decrease in attention have been noted in healthy volunteer adults taking topiramate (R. Martin et al., 1999). Thus, we assessed verbal fluency and attention using the Controlled Oral Word Association Test (Lezak, 1996), the Semantic Category Naming Test (Lezak, 1996), and the Vigilance and Delay Task of the Gordon Diagnostic System (Gordon, 1983). Participants completed the Yale-Brown Obsessive-Compulsive Scale checklist, Controlled Oral Word Association Test, Semantic Category Naming Test, and Gordon Diagnostic System task with the aid of the research assistant. Group home operators completed the Aberrant Behavior Checklist and Repetitive Behavior Scale.

While in the study, the daily activities of the participants were not altered nor was their prescribed caloric intake altered. Participants exercised an average of 45 minutes daily and consumed between 900 and 1,200 baseline calories per day. Based on a token system already in place in these facilities, additional food could be earned for completing tasks and exhibiting appropriate behavior (Dykens & Hodapp, 1997; Lowenstein, 1996; Page et al., 1983).

Appetite was assessed during one hour of free access to food (low-calorie) at the baseline visit and Weeks 2, 4, and 8 (Holland et al., 1993). Test food was presented in the form of sandwich quarters that were, on average, 273 kcal and comprised of low-calorie bread (40 kcal), luncheon meat (9 kcal), and cheese (30 kcal) with no condiments. Sandwiches were prepared in 3 forms: cheese only (275 kcal), luncheon meat only (245 kcal), and cheese and luncheon meat (298 kcal). The number of sandwich quarters consumed was recorded per 15-minute interval of the 1-hour free access period for the type of sandwich quarter chosen. Totals were calculated for the types and total calories consumed. Water was available to the participants throughout the hour, and they were permitted to stop eating at any time during the free access period. Participants were monitored closely for signs of discomfort and distress due to an oc-

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clusion from rapid eating because individuals with Prader-Willi syndrome may have a limited gag reflex and inability to vomit. The start and stop time was recorded for each discrete session.

Appetite was quantified utilizing a "Feelings of Hunger" visual analogue (0 to 5) scale developed by the investigators. The scale was similar to a 10-cm visual analogue scale described by Holland, Treasure, Coskeran, and Dallow (1995). Our scale consisted of pictorial representations of figures with full or empty stomachs, numbers, or brackets that could be used to endorse hunger. Pictorial representations were included to aid the participant in selecting the appropriate level of hunger (Figure 1). We described *hunger* to each participant in terms of "how full his or her belly felt" at the time of questioning (e.g., a rating of a 0 on the scale indicated that the participant was full and would not continue to eat the presented low-calorie food). Participants self-reported their appetite prior to beginning the free access to low-calorie food testing period and following the testing period. They were not encouraged or rewarded with extra sandwiches following endorsement of their feelings of hunger.

Rating scales were completed to evaluate changes in behavior as follows. The group home operators were asked to endorse the occurrence or nonoccurrence of behaviors on the Aberrant Behavior Checklist each week (Aman et al., 1985). The overall number of endorsed behaviors was calculated for each session. Group home operators endorsed obsessive and compulsive behaviors using the Yale-Brown Obsessive-Compulsive Scale checklist at each visit. Self-injury was assessed by endorsement of items on the Self-Injury and Self-Restraint Checklist, a subscale of the Repetitive Behavior Scale developed by Bodfish et al. (1999). Symptom severity was also assessed by the Clinical Global Impression, which was completed by the primary investigator and research assistant. The Clinical Global Impression rating was based on changes in appetite, weight, behavior, and mood for each individual.

Data were analyzed by *t* test conducted to test the hypothesis that the slope of the dependent variables measured over 8 weeks was significantly different from zero.

Results

Topiramate was titrated to an average dose of 162.5 mg at bedtime (SD = 23.15 mg). Side effects, including parathesias, irritability, sedation, and cognitive delays, were mild overall, and topiramate was generally well-tolerated. Side effects were determined by interviews with the participant and group home operators each week and during phone interviews at intermittent times throughout their participation. All 8 participants completed the 8 weeks of treatment. As shown in Table 2, topiramate did not alter appetite as measured by calories during the free access to food period or significantly decrease body mass index (BMI). Reported appetite as measured by the Feelings of Hunger visual analogue scale actually increased. Furthermore, there were no significant changes in the Yale-Brown Obsessive-Compulsive Scale checklist or Clinical Global Impression-Severity Scale (see Table 3). Although no participant got worse, only 2 displayed much or very much improvement by Week 8 on the Clinical Global Impression-Improvement Scale.

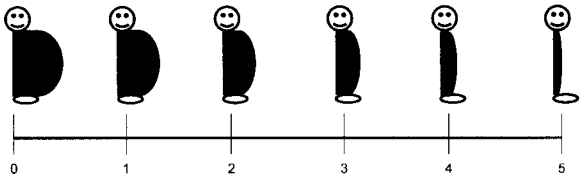

Figure 1. Feelings of Hunger Scale.

In contrast to appetite and weight, there was significant improvement in behavior as demonstrated by the total number of items endorsed on the Aberrant Behavior Checklist, $t(7) = -2.72$, $p = .03$, and reduced self-injury as demonstrated by the Self-Injury Restraint Checklist, $t(7) = -3.83$, $p = .006$ (see Figure 2 and Table 3). Subscales of the Aberrant Behavior Checklist showed a decrease in the overall number of endorsed behaviors; however, these decreases were not significant. While taking topiramate, 7 of 8 individuals who engaged in self-injurious behavior (SIB) showed improvement of symptomology, which included the attenuation of these behaviors and apparent improved healing of self-inflicted wounds. At the time of participation, the seventh participant to engage in SIB was not identified by the investigators. However, we became aware of his SIB retrospectively. During follow-up conversations, this individual's parent reported that the subject's nail-biting and ripping of his cuticles had significantly improved throughout the study period and had continued during follow-up, to the point that it had decreased to almost an indistinguishable lev-

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Table 2. Measures of Appetite Regulation in Adults With Prader-Willi Syndrome During an 8-Week Open-Label Trial of Topiramate ($N = 8$)

Measure	Baseline		8-week		Analysis (slope), $t(7)$
	Score	*SD*	Score	*SD*	
Caloric intake (kcal)	1198	397	1378	581	0.61
Body Mass Index	30.16	4.67	29.93	4.98	−1.68
Feelings of hunger	4.13	1.36	4.75	0.71	2.95*
Clinical Global Impression[a]-Severity	4.13	0.83	3.88	0.83	−1.52

[a]7-point scale.
*$p < .05$.

el. Overall, for the 6 Prader-Willi syndrome individuals who were known to engage in SIB at the time of the study (particularly skin-picking), there was a clinically noticeable decrease in the size of most primary lesions and number of lesions (from a mean of 2.5 to a mean of 1 based on report of group home operators). A case report of 3 of the participants in this study can be found in Shapira, Lessig, Murphy, Driscoll, and Goodman (2002). Comparable observations were noted in the 3 subsequent participants in addition to the 3 reported on previously.

In terms of possible cognitive effects reported in the literature, there were no significant changes on the Controlled Oral Word Association Test or the Vigilance Task, but there was an unexpected improvement in the Semantic Category Naming Test, $t(7) = 2.51$, $p = .04$, and a trend towards improvement in the Delay Task, $t(7) = 2.28$, $p = .06$ (see Table 3).

Discussion

This study represents the largest reported investigation of anticonvulsant medication use for appetite and behavior control in adults with Prader-Willi syndrome. We found that topiramate did not help appetite control or weight for these individuals, as measured by calorie consumption during free access to food, visual analogue scale, or BMI. This result is contrary to our hypothesis and inconsistent with the positive response to topiramate that has been noted in individuals with obesity as a result of binge-eating disorder and from the administration of weight-increasing medications (Lessig et al., 2001; McElory et al., 2003; Shapira et al., 2000).

These negative findings on appetite control could be the result of a number of factors, including small sample size, concomitant psychotropic medications, or short duration of this open-

Table 3. Other Measures of Interest

Measure[a]	Baseline		8-week		Analysis (slope) $t(7)$
	Score	*SD*	Score	*SD*	
Y-BOCS	7.25	5.87	7.13	6.03	−.09
GDS					
Efficiency ratio (Delay Task)	0.31	1.96	0.53	0.25	2.28
Vigilance Task	33	9.91	35.38	9.24	0.25
COWAT	23	7.75	21.63	3.96	−0.91
SCNT	20.63	4.37	21	2.73	2.51*
ABC-modified	7.63	6.82	5.63	4.37	−2.72*
SIB-C	2.13	1.96	1.25	1.67	−3.83**

[a]Y-BOCS = Yale-Brown Obsessive-Compulsive Scale Checklist: GDS = Gordon Diagnostic System; COWAT = Controlled Oral Word Association Test; SCNT = Semantic Category Naming Test; ABC = Aberrant Behavior Checklist-Modified. SIB-C = Self-Injury and Self-Restraint Checklist.
*$p < .05$. **$p < .01$.

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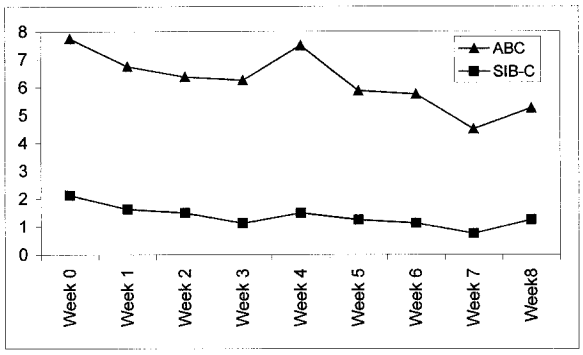

Figure 2. Average number of endorsed behaviors on the Aberrant Behavior Checklist (ABC) and Self-Injury and Self-Restraint Checklist (SIB-C).

label study. The addition of topiramate to several psychotropic medications was consistent with the Federal Drug Administration and pharmaceutical manufacturer's recommendation of the use of topiramate as an adjunctive therapy in epilepsy; however, the use of topiramate as a monotherapy may have produced different results. Two participants were medication free at enrollment, one participant was started on sertraline, and the other maintained medication-free status throughout participation. The medication-free participant experienced a significant reduction in skin-picking and a modest weight loss (1.47 kg). Few researchers have looked at the efficacy of topiramate as a monotherapy (Conner, 2002; Cross, 2002). Furthermore, topiramate may have been underdosed; doses have been reported from 25 mg to 1600 mg (Ortho-McNeil Pharmaceuticals, 2000; Shapira et al., 2000). In addition, our participants were all in well-controlled group-home settings and although obese, they may have been closer to goal weights than nonsupervised individuals with Prader-Willi syndrome in the community.

On the other hand, it is possible that these findings demonstrate that the genetic makeup of Prader-Willi syndrome alters the expected response to topiramate. Several possible mechanisms of action have been identified for this medication (Privatera, 1997): (a) state-dependent blockade of voltage-activated Na^+ channels, (b) facilitation of GABAergic activity at a nonbenzodiazepine site on γ-aminobutyric acid ($GABA_A$) receptors, and (c) antagonism of kainate/AMPA type glutamate receptors. Interestingly, stimulation in rats of the lateral hypothalamus by glutamate agonists, including kainite/AMPA agonists, causes a rapid and intense dose-dependent increase in food intake (Stanley, Ha, Spears, & Dee, 1993; Stanley, Willett, Donias, Ha, & Spears, 1993), and researchers have hypothesized that topiramate's positive effects in binge-eating disorder relates to its kainate/AMPA glutamate receptor antagonism (McElroy et al., 2003; Shapira et al., 2000). Within the deleted region of chromosome 15 are proteins that synthesize the production of three GABA receptor subunits, beta-3, alpha-5, and gamma-3. The lack of these receptor subunits may be responsible for our finding that topiramate did not have an effect on appetite.

Conversely, we were surprised by the significant improvements in behavior observed following drug treatment, particularly skin-picking. In addition to its effect on behaviors, topiramate also appeared to improve wound healing and, thus, was a factor in the healing of skin lesions. As noted above, our research group reported on 3 of the 6 individuals included in this review of the effect of topiramate on skin-picking (Shapira et al., 2002). These individuals continued to maintain positive changes throughout their follow-up period, although 1 subject voluntarily elected to be taken off the medication approximately 8 months after completing the trial. This trial was not systematically designed to evaluate topiramate's effects on SIB. Therefore, these apparent improvements should be viewed cautiously. In order to address this issue, we are currently conducting follow-up studies in a blinded, cross-over manner based on our observations with topiramate for wound healing and SIB, with direct observation of lesion improvement in individuals with Prader-Willi syndrome.

Topiramate did not have an overtly positive effect on compulsive behaviors in these 8 individuals. To date, in other clinical populations that exhibit symptoms of compulsions, the use of topiramate has not been fully evaluated. Overall, in terms of Prader-Willi syndrome, Feurer et al. (1998) reported on administration of the Compulsive Behavior Checklist to 75 individuals to evaluate the 25 endorsable items. Of these items, skin-picking did not load on the general factor and should be considered as a separate behavior or unique item when evaluating these individuals. This finding is consistent with our findings of a differential response to topiramate for SIB and compulsions.

All 8 Prader-Willi syndrome participants chose to continue on topiramate after the trial. One participant stopped due to lack of weight/

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appetite control after 5 months and one requested to stop the medication, although not for clinical purposes, after 8 months. She was benefiting in terms of self-injury and other behaviors but decided she did not want to take the medicine anymore. Thus, she was titrated off the medication slowly and, consequently, her symptoms began to return. She had gained approximately 0.4 kg during the 8 months on topiramate. Individuals in these specialized group homes without any medication augmentation typically lose weight at a steady pace, approximately .227 kg per week (M. Lister, personal communication, August 20, 2002). The 6 other participants continued taking topiramate (8.17 months, $SD = 4.53$), with a decrease in weight of approximately 50% of what might be expected for that time period (3.68 kg, $SD = 1.35$). However, they did experience continued improvement in terms of behavior and self-injury.

Topiramate resulted in a decrease in total Aberrant Behavior Checklist scores, although a time-dependent change in individual subscales was not significant. This outcome represents a change in the number of items endorsed on the Aberrant Behavior Checklist and not severity. By collapsing the rating measurement from a 4-point rating of severity to simply endorsement of behavior, we limited the sensitivity of the rating measurement. Had we asked the group home operators to also rate the severity of the behaviors reported on the Aberrant Behavior Checklist, a more sensitive estimate of treatment outcome might have been apparent.

Skin-picking is a very serious problem in the Prader-Willi syndrome population (Dykens, Cassidy, & King, 1999) and may lead to serious consequences, such as cellulitus and osteomylitus. To date, there have been no medications or effective behavior modification strategies to alleviate this problem. Thus, the positive preliminary findings reported in this study and by Smathers et al. (2003) warrant follow-up with a more extensive, controlled study. Finding an effective treatment for skin-picking in the Prader-Willi syndrome population would be a significant medical advancement for this group.

References

Aman, M., Singh, N., Stewart, A., & Field, C. J. (1985). The Aberrant Behavior Checklist: A behavior rating scale for the assessment of treatment effects. *American Journal of Mental Deficiency, 89,* 485–491.

Baptista, T., Kin, N. M. K. N. Y., Beaulieu, S., & de Baptista, E. A. (2002). Obesity and related metabolic abnormalities during antipsychotic drug administration: Mechanisms, management and research perspectives. *Pharmapsychiatry, 35,* 205–219.

Bodfish, J. W., Symons, F. J., & Lewis, M. H. (1999). *The Repetitive Behavior Scale* (Western Carolina Center Research Reports). Morganton, NC: Western Carolina Center.

Bodfish, J. W., Symons, F. J., Parker, D. E., & Lewis, M. H. (2000). Varieties of repetitive behavior in autism. *Journal of Autism and Developmental Disabilities, 30,* 237–243.

Conner, G. S. (2002). A double-blind placebo controlled trial of topiramate treatment for essential tremor. *Neurology, 59,* 132–134.

Cross, J. (2002). Topiramate monotherapy for childhood absence seizures: An open-label pilot study. *Seizure, 11,* 406–410.

de Zwaan, M., & Mitchell, J. E. (1992). Opiate antagonists and eating behavior in humans: A review. *Journal of Clinical Pharmacology, 321,* 1060–1072.

Durst, R., Rubin-Jabotinsky, K., Raskin, S., Katz, G., & Zislin, J. (2000). Risperidone in treating behavioural disturbances of Prader-Willi syndrome. *Acta Psychiatrica Scandanavica, 102,* 461–465.

Dykens, E. M., Cassidy, S. B., & King, B. H. (1999). Maladaptive behavior differences in Prader-Willi syndrome due to paternal deletion versus maternal uniparental disomy. *American Journal on Mental Retardation, 104,* 67–77.

Dykens, E. M., & Hodapp, R. M. (1997). Treatment issues in genetic mental retardation syndromes. *Professional Psychology: Research and Practice, 28,* 263–270.

Feurer, I. D., Dimitropoulos, A., Stone, W. L., Roof, E., Butler, M. G., & Thompson, T. (1998). The latent variable structure of the Compulsive Behaviour Checklist in people with Prader Willi syndrome. *Journal of Intellectual Disability Research, 42*(Pt. 6), 472–480.

Glenn, C. C., Saitoh, S., Jong, M. T. C., Filbrandt, M. M., Surti, U., Driscoll, D. J., & Nicholls, R. D. (1996). Expression, DNA methylation, and gene structure of the human *SNRPN* gene. *American Journal of Medical Genetics, 58,* 335–346.

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Goodman, W. K., Price, L. H., Rasmussen, S. A., Mazure, C., Fleischmann, R. L., Hill, C. L., Heninger, G. R., & Charney, D. S. (1989). The Yale-Brown Obsessive Compulsive Scale. I. Development, use, and reliability. *Archives of General Psychiatry, 46,* 1006–1011.

Gordon, M. (1983). *The Gordon Diagnostic System.* Dewitt, NY: Gordon Systems.

Gupta, B. K., Fish, D. N., & Yerevanian, B. I. (1987). Carbamazepine for intermittent explosive disorder in a Prader-Willi syndrome patient [Letter to the editor]. *Journal of Clinical Psychiatry, 47,* 423.

Hoffman, C. J., Aultman, D., & Pipes, P. (1992). A nutrition survey of and recommendations for individuals with Prader-Willi syndrome who live in group homes. *Journal of the American Dietetic Association, 92,* 823–830, 833.

Holland, A. J., Treasure, J., Coskeran, P., & Dallow, J. (1995). Characteristics of the eating disorder in Prader-Willi syndrome: Implications for treatment. *Journal of Intellectual Disability Research, 39,* 373–381.

Holland, A. J., Treasure, J., Coskeran, P., Dallow, J., Milton, N., & Hillhouse, E. (1993). Measurement of excessive appetite and metabolic changes in Prader-Willi syndrome. *International Journal of Obesity and Related Metabolic Disorders, 17,* 527–532.

Inoue, S. (1995). Clinical studies with mazindol. *Obesity Research, 3*(Suppl. 4), 549S–552S.

Inui, A., Uemoto, M., Takamiya, S., Shibuya, Y., Baba, S., & Kasuga, M. (1997). A case of Prader-Willi syndrome with long term mazindol treatment [Letter to the editor]. *Archives of Internal Medicine, 157,* 464.

Itoh, K., Koeda, T., Ohno, K., & Takeshita, K. (1995). Effects of mazindol in two patients with Prader-Willi syndrome. *Pediatric Neurology, 13,* 349–351.

Jerome, L. (1993). Prader-Willi and bipolar illness. *Journal of the American Academy of Child and Adolescent Psychiatry, 32,* 876–877.

Lessig, M. C., Shapira, N. A., & Murphy, T. K. (2001). Topiramate for reversing atypical antipsychotic weight gain [Letter to the editor]. *Journal of the American Academy of Child and Adolescent Psychiatry, 40,* 1364.

Lezak, M. (1996). *Neuropsychological assessment* (2nd ed.). New York: Oxford University Press.

Lowenstein, L. (1996). Diversion tactics. *Nursing Times, 92*(21), 42–43.

Martin, A., Matthew, S., Koenig, K., Schultz, R., Dykens, E. M., Casidy, S. B., & Leckman, J. F. (1998). Prader-Willi syndrome. *American Journal of Psychiatry, 155,* 1265–1273.

Martin, R., Kuzniecky, R., Ho, S., Hetherington, H., Pan, J., Sinclair, K., Gilliam, F., & Faught, E. (1999). Cognitive effects of topiramate, gabapentin, and lamotrigine in healthy young adults. *Neurology, 52,* 321–327.

McElroy, S. L., Arnold, L. M., Shapira, N. A., Keck, P. E., Jr., Rosenthal, N. R., Karim, M. R., Kamin, M., & Hudson, J. I. (2003). Topiramate in the treatment of binge eating disorder associated with obesity: A randomized, placebo-controlled trial. *American Journal of Psychiatry, 160,* 255–261.

McElroy, S. L., Suppes, T., Keck, P. E., Jr., Frye, M. A., Denicoff, K. D., Altshuler, L. L., Brown, E. S., Nolen, W. A., Kupka, R. W., Rochussen, J., Leverich, G. S., & Post, R. M. (2002). Open-label adjunctive topiramate in the treatment of bipolar disorders. *Biological Psychiatry, 47,* 1025–1033.

Ortho-McNeil Pharmaceuticals (2000). *Top Amax: Updated guide to clinical use* (2nd ed.) [Brochure]. Raritan, NJ: Author.

Page, T. J., Stanley, A. E., Richman, G. S., Deal, R. M., & Iwata, B. A. (1983). Reduction of food theft and long-term maintenance of weight loss in a Prader-Willi adult. *Journal of Behavior Therapy and Experimental Psychiatry, 14,* 261–268.

Powell, S. B., Bodfish, J. W., Parker, D., Crawford, T. W., & Lewis, M. H. (1996). Self-restraint and self-injury: Occurrence and motivational significance. *American Journal on Mental Retardation, 101,* 41–48.

Prader, A., Labhart, A., & Willi, H. (1956). Ein syndrome von adipositas, kleinwuchs, kryptorchismus und oligophrenic nach myotoniertigem zusland in neugeborenanalter. *Schweizerische Medizinische Wochenschrift, 86,* 1260–1261

Privitera, M. D. (1997). Topiramate: A new antiepileptic drug. *Annals of Pharmacotherapy, 31,* 1164–1173.

Selikowitz, M., Sunman, J., Pendergast, A., & Wright, S. (1990). Fenfluramine in Prader-Willi syndrome: A double blind, placebo controlled trial. *Archives of Disease in Childhood, 65,* 112–114.

Shapira, N. A., Goldsmith, T. D., & McElroy, S. L. (2000). Treatment of binge eating disorder

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with topiramate: A clinical case series. *Journal of Clinical Psychiatry, 61,* 368–372.

Shapira, N. A., Lessig, M. C., Murphy, T. K., Driscoll, D. J., & Goodman, W. K. (2002). Topiramate attenuates SIB in Prader-Willi syndrome. *International Journal of Neuropsychopharmacology, 5,* 141–145.

Smathers, S. A., Wilson, J. G., & Nigro, M. A. (2003). Topiramate effectiveness in Prader-Willi syndrome. *Pediatric Neurology, 28*(2), 130–133.

Stanley, B. G., Ha, L. H., Spears, L. C., Dee, M. G., II. (1993). Lateral hypothalamic injections of glutamate, kainic acid, D,L-alpha-amino-3-hydroxy-5-methyl-isoxazole propionic acid or N-methyl-D-aspartic acid rapidly elicit intense transient eating in rats. *Brain Research, 613,* 88–95.

Stanley, B. G., Willett, V. L., III, Donias, H. W., Ha, L. H., & Spears, L. C. (1993). The lateral hypothalamus: A primary site mediating excitatory amino acid-elicited eating. *Brain Research, 630,* 41–49.

Stein, D. J., Keeting, J., Zar, H. J., & Hollander, E. (1994). A survey of the phenomenology and pharmacotherapy of compulsive and impulsive-aggressive symptoms in Prader-Willi syndrome. *Journal of Neuropsychiatry and Clinical Neuroscience, 6,* 23–29.

Tu, J. B., Hartridge, C., & Izawa, J. (1992). Psychopharmacogenetic aspects of Prader-Willi syndrome. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 1137–1140.

Zipf, W. B., & Bernston, G. G. (1987). Characteristics of abnormal food-intake patterns in children with Prader-Willi syndrome and study of effects of naloxone. *American Journal of Clinical Nutrition, 46,* 277–281.

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