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Enantioselective and Rapid Rh-Catalyzed Arylation of *N*-Tosyl- and *N*-Nosylaldimines in Methanol

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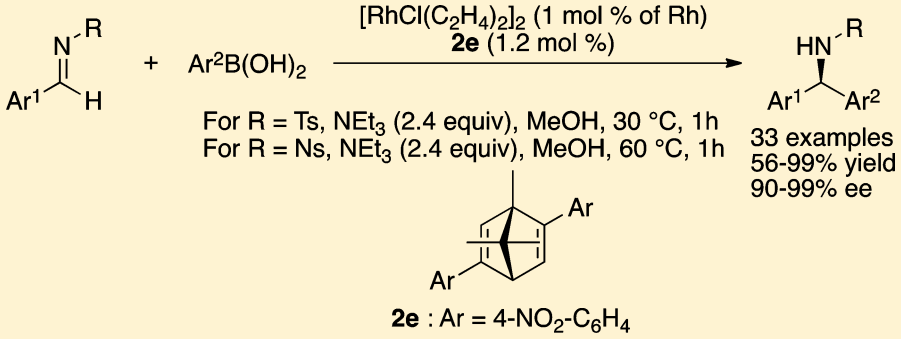
Supporting Information



ABSTRACT: Enantiomerically enriched tosyl-protected diarylmethylamines were rapidly prepared by the asymmetric addition of arylboronic acids to *N*-tosylaldimines under mild conditions in the presence of a catalyst prepared in situ from Rh(I) and a chiral diene ligand. This methodology offers access to diarylmethylamines in good yields with excellent chiral purity at room temperature using MeOH as a solvent and NEt_3 as a base. Its synthetic utility was demonstrated by the preparation of (*S*)-1-phenyl-1,2,3,4-tetrahydroisoquinoline (**14**), an antagonist of the *N*-methyl-D-aspartate (NMDA) receptor.

INTRODUCTION

The chiral diarylmethylamine **1** moiety is seen in many pharmacologically active compounds,[1] such as (+)BW373U86[2] (**1a**) and cetirizine dihydrochloride[3] (**1b**, Zyrtec); the former exhibits potent analgesic and antidepressant effects, while the latter shows selective antagonistic activity toward histamine H1-receptors (Figure 1).

Consequently, the development of efficient enantioselective syntheses of diarylmethylamines has received much interest among synthetic organic chemists resulting in several useful methodologies. Although nucleophilic additions of arylmetallic reagents to chiral auxiliary-based *N*-arylimines,[4a] oxazolidines,[4b−d] and *N*-*tert*-butanesulfinylimines[4g−i] proceed in a highly diastereoselective manner,[4] more effort has been focused on the development of metal-catalyzed enantioselective protocols. For example, the Ir-catalyzed asymmetric hydrogenation of imines derived from substituted benzophenones provides direct access to unprotected chiral diarylmethylamines, although high enantioselectivities are only observed for *ortho*-substituted substrates.[5] In contrast, the Rh-catalyzed asymmetric 1,2-addition of aryl nucleophiles to arylaldimines offers an attractive route to the preparation of chiral diarylmethylamines with high enantio excesses. Various nucleophilic organometallics such as arylstanne,[6] aryltitanium,[7] arylboron,[8] and arylzinc reagents[9] can be used as nucleophiles for this purpose, while by simply selecting which of the aryl groups appear in the nucleophilic reaction partner and the electrophilic reaction partner, respectively, both of the (*R*)- and (*S*)-chiral amines can be synthesized using only a single chiral catalyst. Among the Rh-catalyzed enantioselective addition reactions available to synthetic and process chemists, utilization of arylboron reagents as the aryl source is most attractive due to the ready availability of a diverse range of aryl boronic acids, combined with their relatively low toxicity and wide tolerance of functional groups within the same molecule. Recently, in this field, chiral dienes have been found to be excellent ligands in the Rh-catalyzed asymmetric transformations, prompting significant effort toward the design and investigation of new chiral diene ligands in catalytic asymmetric transformations.[10] The utilization of chiral diene ligands[11] in conjunction with Rh(I) salts in the arylation of a variety of *N*-tosyl aldimines allows high catalytic efficiency and enantioselectivity similar to that achieved by the use of chiral phosphorus-based ligands.[8a,b] These Rh/chiral diene catalyzed asymmetric arylations, however, have to be conducted at above room temperature (50−60 °C) and can

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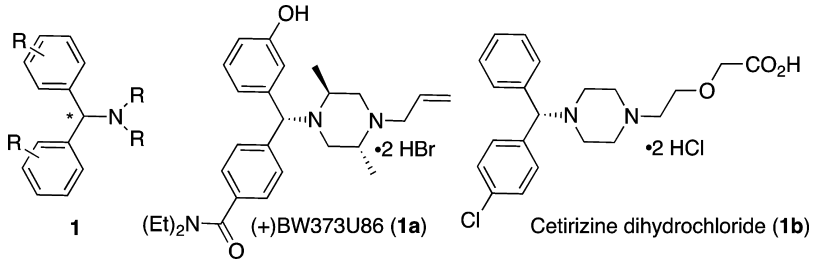
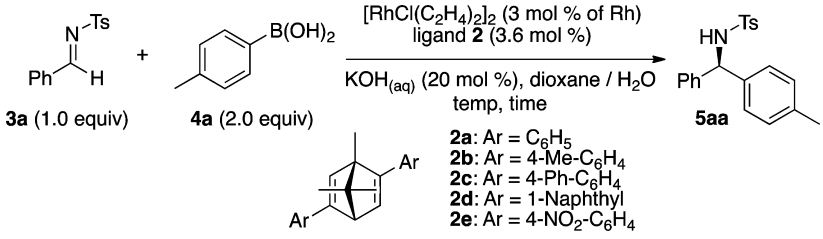


Figure 1. Selected pharmacologically active compounds containing a chiral diarylmethylamine moiety.

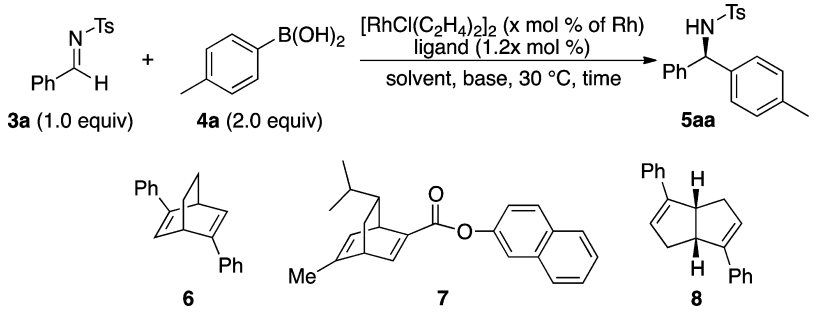
Table 1. Ligand Effect on the Asymmetric Addition of *p*-Tolylboronic Acid (4a) to Aldimine 3a



entry[a]	ligand	temp (°C)	time (h)	yield[b] (%)	ee[c] (%)
1	**2a**	60	1.0	84	94
2	**2a**	30	24	99	93
3	**2b**	30	24	99	92
4	**2c**	30	24	98	87
5	**2d**	30	24	41	92
6	**2e**	30	4.5	80	94

[a]The reaction was conducted with 0.1 mmol of imine **3a**. [b]Calibrated GC yield using *n*-decane as an internal standard. [c]Determined by chiral HPLC, see the Experimental Section.

Table 2. Optimization of Reaction Conditions



entry[a]	ligand	*x*	solvent	base	time (h)	yield[b] (%)	ee[c] (%)
1	**2e**	3.0	dioxane	KOH	4.5	80	94
2	**2e**	3.0	THF	KOH	24	23	94
3	**2e**	3.0	MeOH	KOH	6.0	61	93
4	**2e**	3.0	EtOH	KOH	24	43	92
5	**2e**	3.0	dioxane	CsOH	24	85	95
6[d]	**2e**	3.0	dioxane	NEt_3	24	70	94
7[d]	**2e**	3.0	dioxane	DIPA	24	45	95
8[d]	**2e**	3.0	MeOH	NEt_3	1.0	96	96
9[d,e]	**2e**	1.0	MeOH	NEt_3	1.0	84[f]	96
10[d,e]	**2a**	1.0	MeOH	NEt_3	1.0	86[f]	90
11[d,e]	**6**	1.0	MeOH	NEt_3	1.0	67[f]	−97
12[d,e]	7	1.0	MeOH	NEt_3	1.0	85[f]	90
13[d,e]	**8**	1.0	MeOH	NEt_3	1.0	trace	N.D.[g]
14[d]	**8**	3.0	MeOH	NEt_3	1.0	85[f]	−98

[a]The reaction was conducted with 0.1 mmol of imine **3e**. [b]Calibrated GC yield using *n*-decane as an internal standard. [c]Determined by chiral HPLC; see the Experimental Section. [d]2.4 equiv of base were used. [e]The reaction was conducted with 0.3 mmol of imine **3a**. [f]Isolated yield. [g]N.D. = not determined.

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require up to about 12 h to complete. Given this, we were interested in developing a catalyst system that could be used for the rapid preparation of enantioenriched diarylmethylamines under mild reaction conditions.

Recently, we reported the synthesis and application of a series of novel and stable C_1-symmetric chiral 2,5-diarylsubstituted bicyclo[2.2.1]heptadiene ligands **2** for Rh(I)-catalyzed asymmetric conjugate addition of arylboronic acids to electron-deficient acceptors.[12] These reactions provide the corresponding addition adducts in high yield with high ee values while using low catalyst loadings.[12a] Encouraged by our earlier results, we subsequently investigated the employment of chiral dienes **2** as ligands in the Rh(I)-catalyzed asymmetric addition of arylboronic acids to *N*-tosylaldimines. Herein, we report the results of this work, which comprises an efficient methodology for access to chiral diarylmethylamines of high optical purity.

RESULTS AND DISCUSSION

Investigations were initiated with an evaluation of the catalytic activity of chiral dienes **2** in the Rh(I)-catalyzed asymmetric addition of *p*-tolylboronic acid (**4a**) to *N*-tosyl-protected imine **3a** in aqueous dioxane with KOH as base (Table 1). At 60 °C in the presence of 3 mol % of Rh/**2a**, the asymmetric addition reaction was complete within 1 h furnishing diarylmethylamine **5aa** in 84% yield with 94% ee (entry 1). The only moderately high yield was a result of partial hydrolysis of imine **3a**, and it was therefore anticipated that a better chemical yield would be achieved at lower temperatures. Indeed, at only 30 °C the asymmetric addition reaction proceeded smoothly, albeit less rapidly (24 h), providing amine **5aa** in a much improved 99% yield with 93% ee (entry 2). Subsequently, a variety of our ligands with various substituents at the 2,5-position of the bicyclo[2.2.1] skeleton were tested. Ligands bearing 4-methylphenyl (**2b**) and 4-biphenyl (**2c**) substituents gave excellent yields with slightly less enantioselectivity (entries 3 and 4), and while chiral diene **2d** was optimal in the enantioselective 1,4-addition of arylboronic acids to acyclic α,β-unsaturated carbonyl compounds,[12a] it failed to show comparable catalytic activity in this study, giving rise to amine **5aa** in only 41% yield (entry 5). Enantioinduction equivalent to that with ligand **2a** was observed when the catalytic reaction was carried out in the presence of ligand **2e**[12b] within 4.5 h at 30 °C (entry 6), but a slightly lower yield (80%) was observed. The absolute configuration of the stereogenic center was determined to be *R* by X-ray crystallographic analysis of compound **5aa**.[13]

Next, a base and solvent study was conducted using ligand **2e** at 30 °C (Table 2). Whereas the reaction carried out in THF using 20 mol % of aqueous KOH solution gave amine **5aa** in a poor 23% yield with 94% ee after 24 h (entry 2), moderately improved chemical yields with high selectivity were obtained in alcohol solvents (entries 3 and 4). Replacing the base with aqueous CsOH, triethylamine (NEt_3), or diisopropylamine (DIPA) in dioxane still did not meet our yield expectations (entries 5−7). Pleasingly, however, when the reaction was carried out employing NEt_3[4i,14] as the base in MeOH, consumption of the starting material was very rapid (within 1 h), furnishing the desired amine **5aa** in excellent chemical yield (96%) with 96% ee (entry 8); notably, no negative impact on the asymmetric induction was observed when 1 mol % of the Rh/**2e** complex was utilized (entry 9).[15] Since the use of dioxane as a solvent in pharmaceutical manufacturing is highly undesirable due to its relatively high toxicity, it was pleasing that the comparatively less toxic alcohol, MeOH, could be used as a solvent in this reaction giving this methodology industrial applicability.[16] While the Rh(I) catalyst comprising ligand **2a** was found to provide a similar level of selectivity as did that of ligand **2e** in the screening tests conducted in dioxane (Table 1, entry 2 vs entry 6), the former, however, produced less asymmetric induction than did the latter when the Rh(I)-catalyzed asymmetric reaction was carried out in MeOH using Et_3N as a base at 30 °C, yielding 86% of adduct **5aa** in a diminished 90% ee (Table 2, entry 10).

To test the generality of the optimized reaction conditions, commercially available chiral diene ligands were employed in the enantioselective 1,2-addition of *p*-tolylboronic acid (**4a**) to *N*-tosyl-protected imine **3a** (entries 11−14). In the presence of 1.0 mol % of Rh catalysts comprising ligands **6**[11c] and **7**[11d] that bear a bicyclo[2.2.2] skeleton, and ligand **8** possessing a bicyclo[3.3.0] framework, compound **5aa** was obtained in 67%, 85%, and only trace yield with 97%, 90%, and nondetermined ee, respectively (entries 11−13). When the reaction using ligand **8** was repeated using 3 mol % of Rh catalyst a much improved 85% yield and 98% ee was noted (entry 14). When evaluated on the basis of a combination of both yield and enantioselectivity, this comparison of ligands **2e**, **6**, **7**, and **8** under identical conditions suggests that ligands **2e** exhibit equal or better performance in this reaction.

After establishing the optimal reaction conditions specified in Table 2, entry 9, for the asymmetric addition reaction of *p*-tolylboronic acid (**4a**) to benzaldehyde-derived *N*-tosylaldimine **3a**, the scope was further examined with a diverse array of arylboronic acids and *N*-tosylaldimines (Table 3). Reactions between *p*-tolylboronic acid (**4a**) and various arylimines **3a−l** furnished chiral *N*-tosyl-protected diarylmethylamines **5aa−la** in good to excellent yields (68−93%) along with excellent enantioselectivities (92−98% ee), regardless of the electronic properties of the arylimines being investigated (entries 2−12). Good chemical yields and enantioinduction were observed for substrates derived from 2-naphthaldehyde (entry 10), 2-furaldehyde (entry 11), and 2-thienylaldehyde (entry 12). In addition, high catalytic activity and enantioselectivity were also observed in the enantioselective additions of arylboronic acids substituted with either electron-withdrawing or electron-donating groups, to aldimines (**3a**, **3m**, and **3n**) (entries 13−25). Notably, although a longer reaction time was required and a correspondingly inferior yield was witnessed for the reaction of *o*-tolylboronic acid (**4g**) with benzaldehyde-derived aldimine **3a**, an excellent 97% ee was still obtained (entry 18). Presumably, the poorer conversion rate was the result of steric hindrance of the *ortho*-substituted aryl nucleophile, and although not yet examined, further optimization of the conditions might provide an improved result. A key advantage of applying this approach to chiral diarylmethylamine synthesis is that either enantiopode can be accessed by appropriate assignment of each of the aryl groups to either the nucleophilic or electrophilic reaction component while only requiring a single chiral catalyst. For example, by comparison of entry 1 and 24, entry 3 and 20, entry 7 and 19, entry 10 and 22, and entry 18 and 25, it can be seen that the same catalyst was able to provide both pairs of enantiomers with comparable ee's despite the requisite reversed assignment of the aryl groups.

The more readily cleaved 4-nitrophenyl sulfonyl protecting group was also examined as an alternative to the 4-tosyl analogue (Table 4).[17] While no desired product was observed

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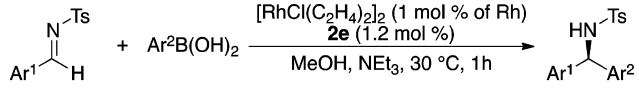
Table 3. Substrate Scope of Enantioselective Addition Reaction to *N*-Tosylaldimines

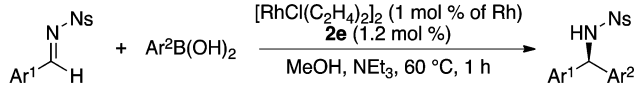


3 (1.0 equiv) **4** (2.0 equiv) **5**

entry[a]	Ar^1	Ar^2	yield[b] (%)	ee[c] (%)
1	C_6H_5 (**3a**)	4-MeC_6H_4 (**4a**)	84 (**5aa**)	96
2	3-ClC_6H_4 (**3b**)	4-MeC_6H_4 (**4a**)	70 (**5ba**)	95
3	4-ClC_6H_4 (**3c**)	4-MeC_6H_4 (**4a**)	83 (**5ca**)	94
4	2,4-$Cl_2C_6H_3$ (**3d**)	4-MeC_6H_4 (**4a**)	75 (**5da**)	94
5	3,4-$Cl_2C_6H_3$ (**3e**)	4-MeC_6H_4 (**4a**)	92 (**5ea**)	94
6	3-FC_6H_4 (**3f**)	4-MeC_6H_4 (**4a**)	74 (**5fa**)	94
7	4-FC_6H_4 (**3g**)	4-MeC_6H_4 (**4a**)	93 (**5ga**)	96
8	3-BrC_6H_4 (**3h**)	4-MeC_6H_4 (**4a**)	83 (**5ha**)	94
9	3-MeC_6H_4 (**3i**)	4-MeC_6H_4 (**4a**)	88 (**5ia**)	97
10	2-naphthyl (**3j**)	4-MeC_6H_4 (**4a**)	91 (**5ja**)	93
11	2-furyl (**3k**)	4-MeC_6H_4 (**4a**)	68 (**5ka**)	99
12	2-thienyl (**3l**)	4-MeC_6H_4 (**4a**)	91 (**5la**)	92
13	C_6H_5 (**3a**)	4-FC_6H_4 (**4b**)	95 (**5ab**)	96
14	C_6H_5 (**3a**)	4-ClC_6H_4 (**4c**)	76 (**5ac**)	97
15	C_6H_5 (**3a**)	4-$MeOC_6H_4$ (**4d**)	89 (**5ad**)	94
16	C_6H_5 (**3a**)	2-naphthyl (**4e**)	89 (**5ae**)	96
17	C_6H_5 (**3a**)	4-PhC_6H_4 (**4f**)	74 (**5af**)	98
18[d]	C_6H_5 (**3a**)	2-MeC_6H_4 (**4g**)	56 (**5ag**)	97
19	4-MeC_6H_4 (**3m**)	4-FC_6H_4 (**4b**)	82 (*ent*-**5ga**)	97
20	4-MeC_6H_4 (**3m**)	4-ClC_6H_4 (**4c**)	81 (*ent*-**5ca**)	96
21	4-MeC_6H_4 (**3m**)	4-$MeOC_6H_4$ (**4d**)	80 (**5md**)	96
22	4-MeC_6H_4 (**3m**)	2-naphthyl (**4e**)	97 (*ent*-**5ja**)	96
23	4-MeC_6H_4 (**3m**)	4-PhC_6H_4 (**4f**)	99 (**5mf**)	96
24	4-MeC_6H_4 (**3m**)	C_6H_5 (**4h**)	91 (*ent*-**5aa**)	95
25[e]	2-MeC_6H_4 (**3n**)	C_6H_5 (**4h**)	96 (*ent*-**5ag**)	98

[a]The reaction was conducted with 0.3 mmol of imine **3** and 2.4 equiv of NEt_3. [b]Isolated yield. [c]Determined by chiral HPLC, see the Experimental Section. [d]The reaction was carried for 3 h. [e]The reaction was carried out for 2 h.

Table 4. Substrate Scope of Enantioselective Addition Reaction to *N*-Nosylaldimines



9 (1.0 equiv) **4** (2.0 equiv) **10**

entry[a]	Ar^1	Ar^2	yield[b] (%)	ee[c] (%)
1	C_6H_5 (**9a**)	4-MeC_6H_4 (**4a**)	78 (**10aa**)	95
2	C_6H_5 (**9a**)	4-$MeOC_6H_4$ (**4d**)	68 (**10ad**)	99
3	C_6H_5 (**9a**)	3-MeC_6H_4 (**4i**)	93 (**10ai**)	90
4	C_6H_5 (**9a**)	3−ClC_6H_4 (**4j**)	67 (**10aj**)	99
5	4-ClC_6H_4 (**9b**)	C_6H_5 (**4h**)	83 (**10bh**)	92
6	4-MeC_6H_4 (**9c**)	C_6H_5 (**4h**)	87 (*ent*-**10aa**)	97
7	4-MeC_6H_4 (**9c**)	4-$MeOC_6H_4$ (**4d**)	57 (**10cd**)	99

[a]The reaction was conducted with 0.3 mmol of imine **9** and 2.4 equiv of NEt_3. [b]Isolated yield. [c]Determined by chiral HPLC; see the Experimental Section.

under the optimal conditions established above, apparently due to insolubility in MeOH at 30 °C, the enantioselective reactions of *N*-nosylaldimines **9a**−**c** and arylboronic acids **4a**−**i** furnished the corresponding 1,2-addition adducts **10aa**−**cd** with excellent enantioselectivities (90−99% ee) and with generally good yields when the reaction was conducted at 60 °C rather than at 30 °C.

Finally, to demonstrate the synthetic utility of this methodology, the enantioselective synthesis of (*S*)-1-phenyl-1,2,3,4-tetrahydroisoquinoline (**14**), a more potent antagonist of the NMDA receptor[18] than its (*R*)-enantiomer, was conducted (Scheme 1). In the key step, asymmetric 1,2-addition of phenylboronic acid (**4h**) to *N*-tosylaldimine **11**[19] catalyzed by the Rh(I)/**2e** complex furnished chiral diarylmethylamine **12** in 96% yield with 95% ee, despite the presence of an *ortho*-substituent in imine **11**. Subsequent fluoride-mediated removal of the TBDPS protecting group gave alcohol **13** in 86% yield, which due to sufficient pK_a augmentation of the amino group resulting from the *N*-tosyl substituent, cyclized under Mitsunobu[20] conditions. The ensuing reductive deprotection of the *N*-tosyl group yielded (*S*)-1-phenyl-1,2,3,4-tetrahydroisoquinoline (**14**)[21] with 96% ee in 71% yield over two steps from alcohol **13**.

In summary, a rapid and efficient protocol for the enantioselective addition of arylboronic acids to *N*-tosylaldimines catalyzed by rhodium complexes of novel chiral diene ligands under mild conditions has been developed. Although a range of diene ligands were applicable, ligand **2e** was preferred. For *N*-tosylaldimines, the asymmetric addition proceeded at room temperature (30 °C) offering high yields of *N*-tosyl-protected diarylmethylamines with high optical purity, whereas *N*-nosylaldimines reacted at 60 °C, due to the lower solubility of these analogues. Additionally, this methodology allows ready access to both enantiomers of diarylmethylamines with comparable enantioenrichment while using the same single chiral catalyst. To demonstrate the synthetic usefulness, the enantioselective synthesis of (*S*)-1-phenyl-1,2,3,4-tetrahydroisoquinoline (**14**) was conducted. The use of acceptably low loadings of the catalyst, MeOH as solvent, an ambient reaction temperature, the use of a noncorrosive base, and the rapid rate of reaction lends this reaction system to industrial applications. Probing the structure of the active catalytic species for this catalytic system and its further expansion for the synthesis of enantioenriched amines is currently under intensive investigation in our laboratory.

EXPERIMENTAL SECTION

General Methods. All commercial chemicals and solvents were reagent grade and were used without further treatment unless otherwise noted. All reactions were carried out under an atmosphere of argon gas. Reactions were monitored by TLC using silica gel plates; zones were detected visually under ultraviolet irradiation (254 nm) or by spraying with 2,4-dinitrophenylhydrazine solution followed by heating. Flash column chromatography was done using silica gel. ^1H NMR spectra were obtained on 400 or 500 MHz spectrometers. ^{13}C NMR spectra were obtained on 100 or 125 MHz spectrometers. Chemical shifts were recorded in parts per million (ppm, δ) and were reported relative to the solvent peak. High-resolution mass spectra were obtained using EI, ESI, FAB, or MALDI ionization methods. Optical purity of the final compounds were determined using chiral HPLC. Optical rotations were measured on a polarimeter. Melting points were measured on a melting points apparatus. Phenylboronic acid (**4h**) and chiral dienes **6** and **8** were purchased and used directly. Chiral diene **7**,[11d] chiral bicyclo[2.2.1] diene ligands (**2a**−**e**)[12a] and substituted arylboronic acids[21] were prepared according to the reported procedures. The absolute configuration of the stereogenic center of compound **5aa** was determined by X-ray crystallographic analysis data obtained from a single-crystal diffractometer.

General Procedures for Rhodium-Catalyzed Arylation of *N*-Tosylaldimines. A solution of *N*-tosylaldimine (0.3 mmol),

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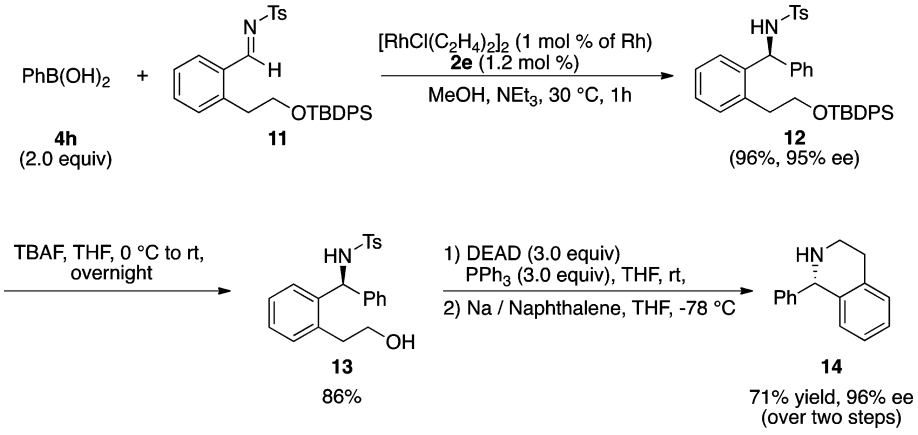
Scheme 1. Enantioselective Synthesis of (*S*)-1-Phenyl-1,2,3,4-tetrahydroisoquinoline (14)



arylboronic acid (0.6 mmol), $[RhCl(C_2H_4)_2]_2$ (0.58 mg, 1.5 μmol, 1 mol % of Rh), and chiral diene ligand **2e** (1.35 mg, 3.6 μmol, 1.2 mol %) in MeOH (2.4 mL) was stirred at 30 °C for 5 min. Et_3N was then added, and the resulting solution was stirred for an additional 1 h at 30 °C. After the volatiles were removed at reduced pressure, the resulting residue was purified by column chromatography over silica gel (hexanes/EtOAc = 8/1), furnishing the desired chiral *N*-tosyldiarylmethylamines.

*(R)-4-Methyl-N-(phenyl(p-tolyl)methyl)benzenesulfonamide (**5aa**).*[11e] Yield: 89 mg, 84%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 6.85 min [(*S*)-enantiomer], 8.03 min [(*R*)-enantiomer]. 96% ee $[\alpha]_D^{31}$ +11.53 (*c* 1.03, $CHCl_3$). FTIR (neat): 3278, 1598, 1445, 1325, 1158, 1090, 1052, 700, 667, 568 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.6 Hz, 2H), 7.22−7.16 (m, 3H), 7.15−7.08 (m, 4H), 7.03−6.94 (m, 4H), 5.52 (d, *J* = 6.8 Hz, 1H), 5.24 (d, *J* = 6.8 Hz, 1H), 2.36 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.1, 140.7, 137.7, 137.4, 137.3, 129.3, 129.2, 128.4, 127.4, 127.28, 127.25, 127.18, 61.1, 21.4, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{21}H_{21}NO_2S + H]^+$ 352.1366, found 352.1381 $[M + H]^+$. Mp: 116−118 °C.

*(S)-N-((3-Chlorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ba**).* Yield: 81 mg, 70%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.07 min [(*R*)-enantiomer], 9.79 min [(*S*)-enantiomer]. 95% ee $[\alpha]_D^{26}$ +6.38 (*c* 0.96, $CHCl_3$). FTIR (neat) 3269, 1596, 1439, 1330, 1159, 1093, 1056, 811, 666, 573 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.0 Hz, 2H), 7.15−7.11 (m, 4H), 7.02 (d, *J* = 8.0 Hz, 4H), 6.93 (d, *J* = 8.0 Hz, 2H), 5.48 (d, *J* = 7.2 Hz, 1H), 5.28 (d, *J* = 7.2 Hz, 1H), 2.38 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.4, 142.6, 137.7, 137.2, 137.0, 134.3, 129.7, 129.4, 127.5, 127.5, 127.18, 127.15, 125.5, 60.7, 21.4, 21.0. HRMS (MALDI-TOF): *m*/*z* calcd for $[C_{21}H_{20}ClNO_2S+Na]^+$ 408.0795, found 408.0813 $[M + Na]^+$. Mp: 95−97 °C.

*(S)-N-((4-Chlorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ca**).*[23] Yield: 96 mg, 83%. The ee was determined on a Chiralpak IB column with hexanes: 2-propanol =80:20, flow =1 mL/min. Retention times: 8.37 min [(*R*)-enantiomer], 9.31 min [(*S*)-enantiomer]. 94% ee $[\alpha]_D^{30}$ +7.71 (*c* 0.99, $CHCl_3$). FTIR (neat): 3277, 1598, 1448, 1326, 1158, 1091, 1052, 811, 668, 568 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.5 Hz, 2H), 7.19−7.14 (m, 4H), 7.06 (d, *J* = 8.5 Hz, 2H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.91 (d, *J* = 8.0 Hz, 2H), 5.49 (d, *J* = 7.0 Hz, 1H), 4.93 (d, *J* = 7.0 Hz, 1H), 2.40 (s, 3H), 2.28 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.4, 139.2, 137.7, 137.23, 137.18, 133.3, 129.4, 128.7, 128.54, 127.2, 60.5, 21.5, 21.0. HRMS (MALDI-TOF): *m*/*z* calcd for $[C_{21}H_{20}ClNO_2S + Na]^+$ 408.0795, found 408.0815 $[M + Na]^+$. Mp: 118−120 °C.

*(S)-N-((2,4-Dichlorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5da**).* Yield: 95 mg, 75%. The ee was determined on a Chiralpak IB column with hexanes: 2-propanol = 80:20, flow = 1 mL/min. Retention times: 6.80 min [(*R*)-enantiomer], 8.56 min [(*S*)-enantiomer]. 94% ee $[\alpha]_D^{26}$ +12.67 (*c* 1.02, $CHCl_3$). FTIR (neat): 3281, 1591, 1470, 1439, 1332, 1160, 1069, 812, 666, 580 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.61 (d, *J* = 8.0 Hz, 2H), 7.35 (d, *J* = 8.5 Hz, 1H), 7.24 (d, *J* = 2.0 Hz, 1H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.13 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.03 (d, *J* = 7.5 Hz, 2H), 6.89 (d, *J* = 8.5 Hz, 2H), 5.80 (d, *J* = 6.5 Hz, 1H), 5.33 (d, *J* = 6.5 Hz, 1H), 2.41 (s, 3H), 2.28 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.6, 138.0, 136.7, 136.4, 135.7, 134.0, 133.4, 130.1, 129.48, 129.5, 127.21, 127.16, 127.09, 57.9, 21.5, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{21}H_{19}Cl_2NO_2S + H]^+$ 420.0586, found 420.0595 $[M + H]^+$. Mp: 116−118 °C.

*(S)-N-((3,4-Dichlorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ea**).* Yield: 116 mg, 92%. The ee was determined on a Chiralpak IB column with hexanes:2-propanol = 80:20, flow = 1 mL/min. Retention times: 8.80 min [(*R*)-enantiomer], 11.79 min [(*S*)-enantiomer]. 94% ee $[\alpha]_D^{26}$ +18.22 (*c* 1.09, $CHCl_3$). FTIR (neat): 3280, 1597, 1447, 1327, 1158, 1093, 1047, 811, 666, 572 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, *J* = 8.0 Hz, 2H), 7.25 (d, *J* = 8.4 Hz, 1H), 7.16−7.12 (m, 3H), 7.03−6.96 (m, 3H), 6.91 (d, *J* = 8.0 Hz, 2H), 5.46 (s, 2H), 2.39 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.6, 140.8, 137.9, 137.0, 136.6, 132.4, 131.5, 130.3, 129.5, 129.4, 129.3, 127.11, 127.09, 126.75, 60.2, 21.5, 21.0. HRMS (FAB^+): *m*/*z* Calcd for $[C_{21}H_{19}Cl_2NO_2S + H]^+$ 420.0586, found 420.0596 $[M + H]^+$. Mp: 118−120 °C.

*(S)-N-((3-Fluorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5fa**).* Yield: 82 mg, 74%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.17 min [(*R*)-enantiomer], 8.93 min [(*S*)-enantiomer]. 94% ee $[\alpha]_D^{28}$ +21.76 (*c* 1.06, $CHCl_3$). FTIR (neat): 3276, 1593, 1487, 1446, 1328, 1159, 1091, 1054, 668, 574 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.57 (d, *J* = 8.0 Hz, 2H), 7.20−7.10 (m, 3H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.95−6.90 (m, 3H), 6.87 (ddd, *J* = 8.0, 8.0, 2.0 Hz, 1H), 6.81 (d, *J* = 9.5 Hz, 1H), 5.50 (d, *J* = 7.0 Hz, 1H), 5.18 (d, *J* = 7.0 Hz, 1H), 2.39 (s, 3H), 2.28 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.7 (d, *J* = 245.0 Hz), 161.7, 143.4, 143.2 (d, *J* = 6.3 Hz), 137.7, 137.2, 137.1, 130.0 (d, *J* = 8.8 Hz), 129.4, 127.2, 122.9 (d, *J* = 2.5 Hz), 114.4 (d, *J* = 2.5 Hz), 114.3, 60.6, 21.4, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{21}H_{20}FNO_2S + H]^+$ 370.1272, found 370.1277 $[M + H]^+$. Mp: 106−108 °C.

*(S)-N-((4-Fluorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ga**).*[23] Yield: 103 mg, 93%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.55 min [(*R*)-enantiomer], 8.72 min [(*S*)-enantiomer]. 96% ee $[\alpha]_D^{31}$ +15.98 (*c* 1.04, $CHCl_3$). FTIR (neat): 3277, 1602, 1508, 1442, 1326, 1226, 1159, 814, 666, 561 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.11−7.06 (m, 2H), 7.02 (d, *J* = 8.0 Hz, 2H), 6.93 (d, *J* = 8.0 Hz, 2H), 6.88 (t, *J* = 8.5 Hz, 2H), 5.50 (d, *J* = 7.0 Hz, 1H), 5.11 (d, *J* = 7.0 Hz, 1H), 2.39 (s, 3H), 2.28 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.0 (d, *J* = 245.0 Hz), 143.3, 137.6, 137.4, 137.3, 136.5 (d, *J* = 3.8 Hz), 129.4, 129.3, 129.0 (d, *J* = 7.5 Hz), 127.19, 127.15, 115.3 (d, *J* = 21.3 Hz), 60.5, 21.5, 21.0. HRMS (FAB^+): *m*/*z* calcd for

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$[C_{21}H_{20}FNO_2S + H]^+$ 370.1272, found 370.1284 $[M + H]^+$. Mp: 114−116 °C.

*(S)-N-((3-Bromophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ha**).* Yield: 107 mg, 83%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.44 min [(*R*)-enantiomer], 10.19 min [(*S*)-enantiomer]. 94% ee $[\alpha]_D^{28}$ +4.78 (*c* 1.11, $CHCl_3$). FTIR (neat): 3272, 1595, 1439, 1359, 1159, 1092, 1055, 811, 665, 573 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$):*δ* 7.55 (d, *J* = 8.0 Hz, 2H), 7.32−7.27 (m, 1H), 7.16−7.13 (m, 3H), 7.08 (d, *J* = 5.0 Hz, 2H), 7.04 (d, *J* = 8.0 Hz, 2H), 6.94 (d, *J* = 8.0 Hz, 2H), 5.48 (d, *J* = 7.0 Hz, 1H), 5.16 (d, *J* = 7.0 Hz, 1H), 2.40 (s, 3H), 2.29 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$):*δ* 143.5, 142.8, 137.8, 137.1, 137.0, 130.5, 130.3, 130.0, 129.4, 127.2, 127.1, 126.0, 122.6, 60.6, 21.5, 21.0. HRMS (MALDI-TOF): *m*/*z* Calcd for $[C_{21}H_{20}BrNO_2S+Na]^+$ 452.0290, found 452.0318 $[M + Na]^+$. Mp: 101−103 °C.

*(S)-4-Methyl-N-(m-tolyl(p-tolyl)methyl)benzenesulfonamide (**5ia**).* Yield: 97 mg, 88%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 5.71 min [(*R*)-enantiomer], 7.81 min [(*S*)-enantiomer]. 97% ee $[\alpha]_D^{26}$ +15.69 (*c* 1.03, $CHCl_3$). FTIR (neat): 3280, 1559, 1449, 1327, 1159, 1094, 1048, 812, 667, 573 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.55 (d, *J* = 8.0 Hz, 2H), 7.20−7.07 (m, 4H), 7.05 (d, *J* = 7.5 Hz, 2H), 7.00 (d, *J* = 8.0 Hz, 2H), 6.93 (d, *J* = 8.0 Hz, 2H), 5.74 (d, *J* = 7.0 Hz, 1H), (d, *J* = 6.0 Hz, 1H), 2.37 (s, 3H), 2.28 (s, 3H), 2.14 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 143.1, 138.3, 137.5, 137.3, 137.0, 135.4, 130.6, 129.24, 129.19, 127.43, 127.37, 127.09, 127.07, 126.1, 57.8, 21.4, 21.0, 19.3. HRMS (FAB^+): *m*/*z* calcd for $[C_{22}H_{23}NO_2S + H]^+$ 366.1522, found 366.1522 $[M + H]^+$. Mp: 120−122 °C.

*(S)-4-Methyl-N-(naphthalen-2-yl(p-tolyl)methyl)benzenesulfonamide (**5ja**).* Yield: 110 mg, 91%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 8.43 min [(*R*)-enantiomer], 10.61 min [(*S*)-enantiomer]. 93% ee $[\alpha]_D^{31}$ −4.79 (*c* 0.99, $CHCl_3$). FTIR (neat): 3274, 1597, 1439, 1327, 1158, 1093, 1055, 813, 668, 558 $cm^{-1.}$ ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.76−7.73 (m, 1H), 7.67−7.62 (m, 2H), 7.54 (d, *J* = 8.5 Hz, 2H), 7.51 (s, 1H), 7.45−7.41 (m, 2H), 7.17 (dd, *J* = 8.5, 1.5 Hz, 1H), 7.04−7.01 (m, 6H), 5.69 (d, *J* = 7.5 Hz, 1H), 5.18 (d, *J* = 7.5 Hz, 1H), 2.28 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 143.2, 137.7, 137.53, 137.50, 137.4, 133.0, 132.6, 129.28, 129.25, 128.4, 128.0, 127.5, 127.4, 127.2, 126.3, 126.2, 126.1, 125.2, 61.3, 21.3, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{25}H_{23}NO_2S]^+$ 401.1444, found 401.1447 $[M]^+$. Mp: 139−141 °C.

*(S)-N-(Furan-2-yl(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5ka**).* Yield: 70 mg, 68%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.63 min [(*R*)-enantiomer], 8.03 min [(*S*)-enantiomer]. 99% ee $[\alpha]_D^{26}$ +22.5 (*c* 1.09, $CHCl_3$). FTIR (neat): 3272, 2923, 1597, 1434, 1330, 1158, 1059, 812, 666, 577 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.58 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 1.0 Hz, 1H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.05−7.04 (m, 4H), 6.18 (dd, *J* = 3.0, 1.5 Hz, 1H), 5.99 (d, *J* = 3.0 Hz, 1H), 5.56 (d, *J* = 7.5 Hz, 1H), 5.23 (d, *J* = 7.5 Hz, 1H), 2.38 (s, 3H), 2.29 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 152.4, 143.1, 142.5, 137.8, 137.4, 135.3, 129.3, 129.2, 127.10, 127.09, 110.2, 108.2, 55.3, 21.4, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{19}H_{19}NO_3S + H]^+$ 342.1158, found 342.1156 $[M + H]^+$. Mp: 125−127 °C.

*(S)-4-Methyl-N-(thiophene-2-yl(p-tolyl)methyl)benzenesulfonamide (**5la**).* Yield: 98 mg, 91%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.89 min [(*S*)-enantiomer], 8.93 min [(*R*)-enantiomer]. 92% ee $[\alpha]_D^{28}$ +7.38 (*c* 1.04, $CHCl_3$). FTIR (neat): 3272, 1598, 1438, 1328, 1159, 1093, 1050, 706, 666, 574 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.58 (d, *J* = 8.5 Hz, 2H), 7.16−7.12 (m, 3H), 7.07−7.00 (m, 4H), 6.82 (dd, 5.0, 4.0 Hz, 1H), 6.68 (d, *J* = 3.5 Hz, 1H), 5.74 (d, *J* = 7.5 Hz, 1H), 5.30 (d, *J* = 7.5 Hz, 1H), 2.38 (s, 3H), 2.30 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 145.1, 143.3, 137.8, 137.4, 137.2, 129.4, 129.2, 127.2, 127.0, 126.7, 126.0, 125.6, 57.3, 21.5, 21.1. HRMS (MALDI-TOF): *m*/*z* Calcd for $[C_{19}H_{19}NO_2S_2 + Na]^+$ 380.0749, found 380.0768 $[M + Na]^+$. Mp: 114−116 °C.

*(R)-N-((4-Fluorophenyl)(phenyl)methyl)-4-methylbenzenesulfonamide (**5ab**).*[23] Yield: 101 mg, 95%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 15.15 min [(*S*)-enantiomer], 16.61 min [(*R*)-enantiomer]. 96% ee $[\alpha]_D^{28}$ −1.78 (*c* 1.00, $CHCl_3$). FTIR (neat): 3268, 1601, 1447, 1327, 1226, 1159, 1092, 814, 668, 567 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.55 (d, *J* = 8.0 Hz, 2H), 7.22−7.21 (m, 3H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.10−7.03 (m, 4H), 6.89 (t, *J* = 8.5 Hz, 2H), 5.55 (d, *J* = 7.0 Hz, 1H), 5.13 (d, *J* = 7.0 Hz, 1H), 2.39 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 162.1 (d, *J* = 245.0 Hz), 143.4, 140.3, 137.3, 136.3 (d, *J* = 3.8 Hz), 129.4, 129.1 (d, *J* = 8.8 Hz), 128.7, 127.8, 127.3, 127.2, 115.4 (d, *J* = 21.3 Hz), 60.7, 21.5. HRMS (FAB^+): *m*/*z* calcd for $[C_{20}H_{18}FNO_2S + H]^+$ 356.1115, found 356.1118 $[M + H]^+$. Mp: 109−111 °C

*(R)-N-((4-Chlorophenyl)(phenyl)methyl)-4-methylbenzenesulfonamide (**5ac**).*[11c] Yield: 85 mg, 76%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.33 min [(*S*)-enantiomer], 8.43 min [(*R*)-enantiomer]. 97% ee $[\alpha]_D^{28}$ +4.01 (*c* 1.03, $CHCl_3$). FTIR (neat): 3267, 1598, 1490, 1447, 1328, 1159, 1090, 701, 665, 568 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.55 (d, *J* = 8.0 Hz, 2H), 7.22−7.19 (m, 3H), 7.18−7.12 (m, 4H), 7.07−7.03 (m, 4H), 5.53 (d, *J* = 7.0 Hz, 1H), 5.26 (d, *J* = 7.5 Hz, 1H), 2.39 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 143.4, 140.1, 139.0, 137.2, 133.5, 129.4, 128.8, 128.7, 128.6, 127.8, 127.3, 127.2, 60.7, 21.5. HRMS (FAB^+): *m*/*z* calcd for $[C_{20}H_{18}ClNO_2S + H]^+$ 372.0820, found 372.0819 $[M + H]^+$. Mp: 125−127 °C.

*(R)-N-((4-Methoxyphenyl)(phenyl)methyl)-4-methylbenzenesulfonamide (**5ad**).*[11c] Yield: 98 mg, 89%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 8.56 min [(*S*)-enantiomer], 11.04 min [(*R*)-enantiomer]. 94% ee $[\alpha]_D^{28}$ +16.00 (*c* 1.19, $CHCl_3$). FTIR (neat): 3227, 2924, 1607, 1512, 1447, 1326, 1252, 1158, 668, 567 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.56 (d, *J* = 8.0 Hz, 2H), 7.21−7.18 (m, 3H), 7.14 (d, *J* = 8.0 Hz, 2H), 7.12−7.08 (m, 2H), 6.99 (d, *J* = 9.0 Hz, 2H), 6.73 (d, *J* = 8.5 Hz, 2H), 5.52 (d, *J* = 7.0 Hz, 1H), 5.06 (d, *J* = 7.0 Hz, 1H), 3.75 (s, 3H), 2.38 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 159.0, 143.1, 140.7, 137.4, 132.7, 129.3, 128.6, 128.5, 127.5, 127.4, 127.3, 127.2, 113.9, 60.8, 55.2, 21.4. HRMS (FAB^+): *m*/*z* Calcd for $[C_{21}H_{21}NO_3S]^+$ 367.1237, found 367.1239 $[M]^+$. Mp: 132−134 °C.

*(R)-4-Methyl-N-(naphthalen-2-yl(phenyl)methyl)benzenesulfonamide (**5ae**).*[24] Yield: 104 mg, 89%. The ee was determined on a Chiralpak AD-H column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 12.51 min [(*R*)-enantiomer], 13.41 min [(*S*)-enantiomer]. 96% ee $[\alpha]_D^{29}$ +24.55 (*c* 1.02, $CHCl_3$). FTIR (neat): 3281, 2923, 1598, 1448, 1325, 1159, 762, 700, 669, 573 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.78 (dd, *J* = 6.0, 3.5 Hz, 1H), 7.67 (d, *J* = 8.5 Hz, 1H), 7.64 (d, *J* = 6.0, 3.5 Hz, 1H), 7.55 (d, *J* = 8.5 Hz, 2H), 7.50 (s, 1H), 7.45 (dd, *J* = 6.0, 3.5 Hz, 2H), 7.24−7.21 (m, 3H), 7.19−7.13 (m, 3H), 7.04 (d, *J* = 8.0 Hz, 2H), 5.74 (d, *J* = 7.5 Hz, 1H), 5.19 (d, *J* = 7.5 Hz, 1H), 2.27 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 143.2, 140.4, 137.5, 137.3, 133.0, 132.7, 129.3, 128.6, 128.5, 128.0, 127.7, 127.53, 127.47, 127.2, 126.4, 126.3, 126.2, 125.1, 61.5, 21.3. HRMS (MALDI-TOF): *m*/*z* calcd for $[C_{24}H_{21}NO_2S + Na]^+$ 410.1185, found 410.1180 $[M + Na]^+$. Mp: 159−161 °C.

*(R)-N-([1,1′-Biphenyl]-4-yl(phenyl)methyl)-4-methylbenzenesulfonamide (**5af**).*[8a] Yield: 92 mg, 74%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 9.25 min [(*R*)-enantiomer], 17.36 min [(*S*)-enantiomer]. 98% ee $[\alpha]_D^{29}$ +11.64 (*c* 1.01, $CHCl_3$). FTIR (neat): 3274, 2923, 1598, 1447, 1327, 1159, 813, 749, 669, 565 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): *δ* 7.58 (d, *J* = 8.5 Hz, 2H), 7.52 (d, *J* = 8.0 Hz, 2H), 7.45−7.40 (m, 4H), 7.34 (t, *J* = 7.0 Hz, 1H), 7.25−7.20 (m, 3H), 7.19−7.11 (m, 6H), 5.62 (d, *J* = 7.0 Hz, 1H), 5.18 (d, *J* = 7.0 Hz, 1H), 2.36 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 143.2, 140.5, 140.5, 140.4, 139.4, 129.4, 128.8, 128.6, 127.8, 127.7, 127.40, 127.35, 127.2, 127.0, 61.1, 21.5. HRMS (MALDI-TOF): *m*/*z* calcd for

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$[C_{26}H_{23}NO_2S + Na]^+$ 436.1342, found 436.1362 $[M + Na]^+$. Mp: 129−131 °C.

*(R)-4-Methyl-N-(phenyl(o-tolyl)methyl)benzenesulfonamide (**5ag**).*[24] Yield: 59 mg, 56%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 5.68 min [(*R*)-enantiomer], 6.27 min [(*S*)-enantiomer]. 97% ee $[\alpha]_D^{25}$ −6.73 (*c* 1.22, CH_2Cl_2). FTIR (neat): 3283, 1598, 1449, 1324, 1158, 1092, 1050, 700, 668 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 7.54 (d, *J* = 8.2 Hz, 2H), 7.20−7.18 (m, 3H), 7.12−7.09 (m, 4H), 7.07−7.04 (m, 4H), 5.80 (d, *J* = 7.1 Hz, 1H), 5.18 (d, *J* = 7.1 Hz, 1H), 2.36 (s, 3H), 2.16 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.1, 139.9, 138.2, 137.4, 135.4, 130.6, 129.3, 128.5, 127.5, 127.2, 127.1, 126.1, 58.0, 21.4, 19.3. HRMS (ESI): *m*/*z* calcd for $[C_{21}H_{21}NO_2S + Na]^+$ 374.1185, found 374.1221 $[M + Na]^+$.

*(R)-N-((4-Fluorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (ent-**5ga**).* Yield: 91 mg, 82%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 7.92 min [(*R*)-enantiomer], 8.91 min [(*S*)-enantiomer]. 97% ee $[\alpha]_D^{31}$ −14.34 (*c* 1.04, $CHCl_3$). HRMS (FAB^+): *m*/*z* calcd for $[C_{21}H_{20}FNO_2S + H]^+$ 370.1272, found 370.1284 $[M + H]^+$.

*(R)-N-((4-Chlorophenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (ent-**5ca**).*[22] Yield: 94 mg, 81%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 8.69 min [(*R*)-enantiomer], 9.44 min [(*S*)-enantiomer]. 96% ee $[\alpha]_D^{30}$ −6.80 (*c* 1.04, $CHCl_3$)

*(R)-N-((4-Methoxyphenyl)(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5md**).*[11e] Yield: 92 mg, 80%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 10.24 min [(*S*)-enantiomer], 11.28 min [(*R*)-enantiomer]. 96% ee $[\alpha]_D^{28}$ +6.27 (*c* 1.01, $CHCl_3$). FTIR (neat): 3276, 2923, 1609, 1511, 1440, 1325, 1250, 1158, 666, 565 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.56 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 7.03−6.95 (m, 6H), 6.72 (d, *J* = 9.0 Hz, 2H), 5.47 (d, *J* = 7.0 Hz, 1H), 5.02 (d, *J* = 7.0 Hz, 1H), 3.75 (s, 3H), 2.39 (s, 3H), 2.28 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 158.9, 143.1, 137.8, 137.5, 137.2, 132.9, 129.3, 129.2, 128.5, 127.22, 127.17, 113.8, 60.6, 55.2, 21.5, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{22}H_{23}NO_3S]^+$ 381.1393, found 381.1392 $[M]^+$. Mp: 123−125 °C.

*(R)-4-Methyl-N-(naphthalen-2-yl(p-tolyl)methyl)benzenesulfonamide (ent-**5ja**).* Yield: 117 mg, 97%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 8.80 min [(*R*)-enantiomer], 11.47 min [(*S*)-enantiomer]. 96% ee $[\alpha]_D^{26}$ +5.40 (*c* 1.04, $CHCl_3$). HRMS (FAB^+): *m*/*z* calcd for $[C_{25}H_{23}NO_2S]^+$ 401.1444, found 401.1443 $[M]^+$.

*(R)-N-([1,1′-Biphenyl]-4-yl(p-tolyl)methyl)-4-methylbenzenesulfonamide (**5mf**).*[8a] Yield: 127 mg, 99%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 10.21 min [(*S*)-enantiomer], 14.93 min [(*R*)-enantiomer]. 96% ee $[\alpha]_D^{28}$ +19.19 (*c* 1.03, $CHCl_3$). FTIR (neat): 3275, 1597, 1445, 1327, 1158, 1054, 811, 758, 666, 574 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.58 (d, *J* = 8.5 Hz, 2H), 7.52 (d, *J* = 8.5 Hz, 2H), 7.44−7.39 (m, 4H), 7.34 (t, *J* = 7.5 Hz, 1H), 7.18 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 7.06−6.99 (m, 4H), 5.57 (d, *J* = 7.0 Hz, 1H), 5.12 (br, 1H), 2.36 (s, 3H), 2.30 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.1, 140.5, 140.4, 139.6, 137.6, 137.5, 137.4, 129.32, 129.29, 128.8, 127.8, 127.4, 127.3, 127.2, 127.0, 60.9, 21.5, 21.0. HRMS (FAB^+): *m*/*z* calcd for $[C_{27}H_{25}NO_2S]^+$ 427.1601, found 427.1602 $[M]^+$. Mp: 173−175 °C.

*(S)-4-Methyl-N-(phenyl(p-tolyl)methyl)benzenesulfonamide (ent-**5aa**).*[8a] Yield: 96 mg, 91%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 6.83 min [(*S*)-enantiomer], 8.24 min [(*R*)-enantiomer]. 95% ee $[\alpha]_D^{30}$ −10.67 (*c* 1.03, $CHCl_3$).

*(S)-4-Methyl-N-(phenyl(o-tolyl)methyl)benzenesulfonamide (ent-**5ag**).* Yield: 101 mg, 96%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 5.73 min [(*R*)-enantiomer], 6.29 min [(*S*)-enantiomer]. 98% ee $[\alpha]_D^{25}$ +6.66 (*c* 1.28, CH_2Cl_2).

General Procedures for Rhodium-Catalyzed Arylation of *N*-Nosylimine. A solution of *N*-nosylimine (0.3 mmol), arylboronic acid (0.6 mmol), $[RhCl(C_2H_4)_2]_2$ (0.58 mg, 1.5 μmol, 1 mol %), and chiral diene ligand **2e** (1.35 mg, 3.6 μmol, 1.2 mol %) in MeOH (2.4 mL) was stirred for 5 min at 60 °C. Et_3N was then added, and the resulting solution was stirred for additional 1 h at 60 °C. After the volatiles were removed at reduced pressure, the resulting residue was purified by column chromatography over silica gel (hexanes/EtOAc = 8/1), furnishing the desired chiral *N*-nosyldiarylmethylamines.

*(R)-4-Nitro-N-(phenyl(p-tolyl)methyl)benzenesulfonamide (**10aa**).* Yield: 90 mg, 78%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 11.63 min [(*S*)-enantiomer], 15.15 min [(*R*)-enantiomer]. 95% ee $[\alpha]_D^{31}$ +4.40 (*c* 0.98, $CHCl_3$). FTIR (neat): 3269, 1527, 1346, 1311, 1165, 849, 736, 611, 555, 462 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.09 (d, *J* = 8.5 Hz, 2H), 7.74 (d, *J* = 8.5 Hz, 2H), 7.22−7.18 (m, 3H), 7.12−7.08 (m, 2H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.97 (d, *J* = 8.0 Hz, 2H), 5.68 (d, *J* = 7.0 Hz, 1H), 5.37 (d, *J* = 7.0 Hz, 1H), 2.27 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 149.6, 146.3, 139.6, 138.0, 136.5, 129.4, 128.7, 128.3, 127.9, 127.33, 127.31, 123.8, 61.5, 21.0. HRMS (ESI): *m*/*z* Calcd for $[C_{20}H_{18}N_2O_4S - H]^-$ 381.0915, found 381.0901 $[M - H]^-$. Mp: 172−174 °C.

*(R)-N-((4-Methoxyphenyl)(phenyl)methyl)-4-nitrobenzenesulfonamide (**10ad**).*[6] Yield: 81 mg, 68%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 14.83 min [(*S*)-enantiomer], 22.00 min [(*R*)-enantiomer]. 99% ee $[\alpha]_D^{25}$ +12.90 (*c* 0.99, $CHCl_3$). FTIR (neat): 3269, 1606, 1527, 1346, 1164, 1026, 842, 735, 611, 551 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.11 (d, *J* = 8.5 Hz, 2H), 7.75 (d, *J* = 8.5 Hz, 2H), 7.22−7.19 (m, 3H), 7.11−7.08 (m, 2H), 7.01 (d, *J* = 8.5 Hz, 2H), 6.73 (d, *J* = 8.5 Hz, 2H), 5.68 (d, *J* = 6.5 Hz, 1H), 5.24 (d, *J* = 6.5 Hz, 1H), 3.74 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 159.4, 149.7, 146.4, 139.6, 131.6, 128.7, 128.3, 128.0, 127.3, 123.8, 114.1, 61.2, 55.30. HRMS (ESI): *m*/*z* Calcd for $[C_{20}H_{18}N_2O_5S-H]^-$ 397.0864, found 397.0849 $[M - H]^-$. Mp: 192−194 °C.

*(R)-4-Nitro-N-(phenyl(m-tolyl)methyl)benzenesulfonamide (**10ai**).* Yield: 107 mg, 93%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 12.48 min [(*R*)-enantiomer], 14.05 min [(*S*)-enantiomer]. 90% ee $[\alpha]_D^{25}$ +3.54 (*c* 0.99, $CHCl_3$). FTIR (neat): 3255, 1605, 1531, 1424, 1346, 1168, 1085, 1037, 736, 702 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, *J* = 8.5 Hz, 2H), 7.73 (d, *J* = 8.5 Hz, 2H), 7.22−7.18 (m, 3H), 7.12−7.08 (m, 2H), 7.08 (d, *J* = 7.5 Hz, 1H), 7.00 (d, *J* = 7.5 Hz, 1H), 6.88 (d, *J* = 8.0 Hz, 2H), 5.67 (d, *J* = 7.5 Hz, 1H), 5.59 (d, *J* = 7.5 Hz, 1H), 2.19 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 149.6, 146.2, 139.3, 139.3, 138.5, 128.68, 128.66, 128.62, 128.3, 128.0, 127.9, 127.3, 124.4, 123.7, 61.7, 21.2. HRMS (MALDI-TOF): *m*/*z* Calcd for $[C_{20}H_{18}N_2O_4S + Na]^+$ 405.0879, found 405.0924 $[M + Na]^+$. Mp: 158−160 °C.

*(R)-N-((3-Chlorophenyl)(phenyl)methyl)-4-nitrobenzenesulfonamide (**10aj**).* Yield: 81 mg, 67%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 19.60 min [(*S*)-enantiomer], 20.35 min [(*R*)-enantiomer]. 99% ee $[\alpha]_D^{25}$ −5.11 (*c* 1.03, $CHCl_3$). FTIR (neat): 3255, 1601, 1530, 1432, 1347, 1311, 1165, 739, 701, 612 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.12 (d, *J* = 8.5 Hz, 2H), 7.76 (d, *J* = 8.5 Hz, 2H), 7.23−7.20 (m, 3H), 7.18−7.14 (m, 2H), 7.09−7.05 (m, 2H), 7.05−7.01 (m, 2H), 5.67 (s, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 149.8, 146.0, 141.4, 138.8, 134.6, 130.0, 128.9, 128.4, 128.2, 128.1, 127.5, 127.3, 125.6, 123.9, 61.2. HRMS (ESI): *m*/*z* calcd for $[C_{19}H_{15}ClN_2O_4S - H]^-$ 401.0368, found 401.0359 $[M-H]^-$. Mp: 167−169 °C.

*(S)-N-((4-Chlorophenyl)(phenyl)methyl)-4-nitrobenzenesulfonamide (**10bh**).*[11e] Yield: 100 mg, 83%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 11.25 min [(*S*)-enantiomer], 16.64 min [(*R*)-enantiomer]. 92% ee $[\alpha]_D^{26}$ +3.23 (*c* 1.08, $CHCl_3$). FTIR (neat): 3289, 3099, 2924, 1525, 1346, 1165, 1089, 842, 735, 608 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.13 (d, *J* = 9.0 Hz, 2H), 7.77 (d, *J* = 9.0 Hz, 2H), 7.22−7.18 (m, 5H), 7.08 (d, *J* = 8.5 Hz, 2H), 7.05−7.02 (m,

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2H), 5.68 (d, J = 7.5 Hz, 1H), 5.55 (d, J = 7.5 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 149.7, 146.1, 139.0, 138.1, 134.1, 128.89, 128.86, 128.7, 128.3, 127.3, 123.9, 61.1. HRMS (MALDI-TOF): m/z calcd for $[C_{19}H_{15}ClN_2O_4S + Na]^+$ 425.0333, found 425.0345 $[M + Na]^+$. Mp: 184−186 °C.

*(S)-4-Nitro-N-(phenyl(p-tolyl)methyl)benzenesulfonamide (ent-**10aa**).* Yield: 100 mg, 87%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 10.51 min [(*S*)-enantiomer], 13.65 min [(*R*)-enantiomer]. 97% ee $[\alpha]_D^{31}$ −4.14 (*c* 0.97, $CHCl_3$).

*(R)-N-((4-Methoxyphenyl)(p-tolyl)methyl)-4-nitrobenzenesulfonamide (**10cd**).*[17c] Yield: 71 mg, 57%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 9.17 min [(*R*)-enantiomer], 10.99 min [(*S*)-enantiomer]. 99% ee $[\alpha]_D^{26}$ +8.33 (*c* 0.98, $CHCl_3$). FTIR (neat): 3285, 1608, 1527, 1347, 1251, 1164, 1034, 851, 737, 620 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09 (d, J = 8.5 Hz, 2H), 7.74 (d, J = 8.5 Hz, 2H), 7.00 (d, J = 8.5 Hz, 4H), 6.96 (d, J = 8.5 Hz, 2H), 6.72 (d, J = 8.5 Hz, 2H), 5.63 (d, J = 7.0 Hz, 1H), 5.30 (d, J = 7.0 Hz, 1H), 3.74 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 159.3, 149.6, 146.4, 137.9, 136.7, 131.7, 129.3, 128.6, 128.3, 127.2, 123.7, 114.0, 61.0, 55.3, 21.0. HRMS (ESI): m/z calcd for $[C_{21}H_{20}N_2O_5S - H]^-$ 411.1020, found 411.1012 $[M - H]^-$. Mp: 174−176 °C.

*(Z)-N-(2-(2-((tert-Butyldiphenylsilyl)oxy)ethyl)benzylidene)-4-methylbenzenesulfonamide (**11**).* A solution of the parent aldehyde[19] (0.185 g, 0.47 mmol), $TsNH_2$ (1 equiv, 82 mg, 0.48 mmol), and PPTS (3 mol %) in toluene (10 mL) was refluxed for 8 h, using a Dean−Stark apparatus to remove water. After the solution was cooled to room temperature, satd $NaHCO_{3(aq)}$ was added. After the mixture was stirred for an additional 5 min, the solution was dried over anhydrous Na_2SO_4 and filtered, and the filtrate was collected and evaporated at reduced pressure. The residue was recrystallized from hexanes−EtOAc (4:1) to furnish the desire imine **8** (0.137 g). Yield: 53%. FTIR (neat): 2932, 2859, 1589, 1324, 1159, 1089, 742, 704, 674, 553 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 9.35 (s, 1H), 8.04 (d, J = 1.0 Hz, 1H), 7.82 (d, J = 2.5 Hz, 2H), 7.48 (td, J = 7.5, 1.0, Hz, 1H), 7.46−7.42 (m, 4H), 7.41−7.35 (m, 2H), 7.32−7.27 (m, 5H), 7.27−7.23 (m, 3H), 3.80 (t, J = 6.0 Hz, 2H), 3.19 (t, J = 6.0 Hz, 2H), 2.40 (s, 3H), 0.93 (s, 9H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 168.7, 144.3, 143.6, 135.44, 135.41, 134.2, 133.2, 132.0, 130.7, 130.6, 129.70, 129.67, 129.58, 128.0, 127.6, 127.0, 126.5, 64.5, 35.5, 26.7, 21.6, 19.0. HRMS (ESI): m/z calcd for $[C_{32}H_{35}NO_3SSi + Na]^+$ 564.1999, found 564.1998 $[M + Na]^+$. Mp: 121−123 °C.

*(S)-N-((2-(2-((tert-Butyldiphenylsilyl)oxy)ethyl)phenyl)(phenyl)methyl)-4-methylbenzenesulfonamide (**12**).* Yield: 174 mg, 96%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 4.93 min [(*R*)-enantiomer], 5.25 min [(*S*)-enantiomer]. 95% ee $[\alpha]_D^{26}$ −1.04 (*c* 1.00, $CHCl_3$). FTIR (neat): 3272, 2931, 2856, 1427, 1327, 1159, 1104, 1091, 703, 571 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.58−7.53 (m, 2H), 7.53−7.50 (m, 2H), 7.46 (d, J = 8.5 Hz, 2H), 7.43−7.37 (m, 2H), 7.37−7.30 (m, 4H), 7.16−7.02 (m, 9H), 6.97 (d, J = 7.0 Hz, 2H), 5.77 (d, J = 6.5 Hz, 1H), 5.00 (d, J = 6.5 Hz, 1H), 3.69−3.57 (m, 2H), 2.84−2.71 (m, 2H), 2.32 (s, 3H), 1.00 (s, 9H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.1, 140.2, 138.2, 137.4, 136.5, 135.5, 133.7, 133.6, 131.0, 129.60, 129.55, 129.3, 128.4, 127.74, 127.65, 127.62, 127.4, 127.1, 126.6, 64.1, 57.6, 35.4, 26.8, 21.4, 19.1, 1.01. HRMS (ESI): m/z calcd for $[C_{38}H_{41}NO_3SSi + Na]^+$ 642.2469, found 642.2473 $[M + Na]^+$. Mp: 84−85 °C.

*(S)-N-((2-(2-Hydroxyethyl)phenyl)(phenyl)methyl)-4-methylbenzenesulfonamide (**13**).* To compound **12** (0.18 g, 0.29 mmol) in THF (1 mL) was added TBAF [0.58 mL (1 M in THF), 0.58 mmol, 2 equiv] dropwise, and after the solution was stirred at 0 °C for 30 min, it was warmed to room temperature. After being stirred overnight, the reaction was quenched with 2 N $NH_4Cl_{(aq)}$, and the aqueous layer was separated and extracted with CH_2Cl_2 (10 mL × 3), the combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, and filtered, the filtrate was concentrated under vacuum, and the resulting oil was purified by column chromatography (hexanes/EtOAc = 2/1) to give the corresponding alcohol **13** as a white solid (0.094 g). Yield: 86%. FTIR (neat): 3505, 3275, 1599, 1450, 1322, 1157, 1045, 754, 669, 572 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.58 (d, J = 8.0 Hz, 2H), 7.22−7.10 (m, 9H), 7.00 (m, 1H), 6.91 (d, J = 8.0 Hz, 1H), 6.52 (d, J = 7.0 Hz, 1H), 5.72 (d, J = 7.0 Hz, 1H), 3.85−3.74 (m, 2H), 2.71−2.58 (m, 2H), 2.37 (s, 3H), 1.72 (br, 1H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.0, 140.8, 140.0, 139.0, 137.6, 137.1, 130.6, 129.3, 129.1, 128.4, 128.0, 127.3, 127.19, 127.18, 126.4, 63.7, 59.1, 34.9, 21.4. HRMS (ESI): m/z calcd for $[C_{22}H_{23}NO_3S + Na]^+$ 404.1291, found 404.1289 $[M + Na]^+$. Mp: 101−103 °C.

(S)-1-Phenyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline.[25] To a solution of alcohol **13** (0.122 g, 0.32 mmol) and PPh_3 (0.25 g, 0.96 mmol, 3 equiv) in THF (1.5 mL) was added diethyl azodicarboxylate (0.15 mL, 0.96 mmol, 3 equiv) slowly, and the solution was stirred for 14 h at room temperature. The volatiles were removed under reduced pressure. The crude compound was purified by column chromatography over silica gel (hexanes/EtOAc = 8/1) to furnish the desired cyclic product (0.105 g). Yield: 91%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol = 80:20, flow = 1 mL/min. Retention times: 6.40 min [(*R*)-enantiomer], 6.64 min [(*S*)-enantiomer]. 95% ee $[\alpha]_D^{27}$ +109.49 (*c* 1.00, $CHCl_3$). FTIR (neat): 3025, 2929, 1491, 1450, 1333, 1158, 1090, 740, 666, 576 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, J = 8.0 Hz, 2H), 7.28−7.23 (m, 3H), 7.21−7.17 (m, 2H), 7.15−7.11 (m, 2H), 7.08 (d, J = 8.0 Hz, 2H), 7.01−6.96 (m, 2H), 6.24 (s, 1H), 3.80−3.73 (m, 1H), 3.35−3.27 (m, 1H), 2.72−2.63 (m, 1H), 2.60−2.53 (m, 1H), 2.32 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 143.0, 141.5, 137.7, 134.0, 133.8, 129.3, 128.9, 128.7, 128.4, 128.2, 127.6, 127.1, 127.0, 126.1, 59.2, 39.0, 26.7, 21.4. HRMS (ESI): m/z calcd for $[C_{22}H_{21}NO_2S + Na]^+$ 386.1185, found 386.1190 $[M + Na]^+$. Mp: 68−69 °C.

*(S)-1-Phenyl-1,2,3,4-tetrahydroisoquinoline (**14**).*[26] To (*S*)-1-phenyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline (0.041g, 0.11 mmol) in THF (0.5 mL) was added a THF solution of Na/naphthalene, and the solution was stirred 15 min at −78 °C before being warmed to room temperature. This reaction was quenched by addition of satd $NH_4Cl_{(aq)}$. The aqueous layer was separated and extracted with CH_2Cl_2 (5 mL × 3). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, and filtered, and the filtrate was concentrated under vacuum to give the crude mixture, which was purified by column chromatography (EtOAc/hexanes = 1/1) to give the desired compound **11** as a white solid (0.018 g). Yield: 78%. The ee was determined on a Chiralpak IB column with hexanes/2-propanol/diethylamine = 50:50:0.1, flow = 1 mL/min. Retention times: 4.43 min [(*S*)-enantiomer], 5.17 min [(*R*)-enantiomer]. 96% ee $[\alpha]_D^{26}$ +9.52 (*c* 0.96, $CHCl_3$). FTIR (KBr pellet) 3417, 3263, 2910, 2789, 1639, 1453, 1119, 951, 741, 699 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.35−7.30 (m, 2H), 7.30−7.26 (m, 3H), 7.15 (d, J = 4.0 Hz, 2H), 7.06−7.02 (m, 1H), 6.75 (d, J = 7.5 Hz, 1H), 5.11 (s, 1H) 3.31−3.25 (m, 1H), 3.13−3.00 (m, 2H), 2.87−2.81 (m, 1H), 1.82 (br, 1H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 144.8, 138.2, 135.4, 129.0, 129.0, 128.4, 128.1, 127.4, 126.2, 125.6, 62.1, 42.2, 29.8. HRMS (EI): m/z calcd for $[C_{15}H_{15}N]^+$ 209.1199, found 209.1207 $[M]^+$. Mp: 78−80 °C.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

NMR spectra and HPLC chromatograms of racemic and enantioenriched products of the 1,2-addition reactions and X-ray crystallographic data of compound **5aa** (CIF). This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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